UNITED STATES DEPARTMENT OF THE INTERIOR

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LITHOLOGIC AND STRATIGRAPHIC DESCRIPTION OF CORES OF ORGANIC-RICH SHALE OF LATE DEVONIAN AND EARLY MISSISSIPPIAN AGE IN NORTHEASTERN KENTUCKY

By

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Lithologic and Stratigraphic Description of Cores of Organic-rich Shale of Late Devonian and Early Mississippian Age in Northeastern Kentucky

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INTRODUCTION

The organic-rich shale of Late Devonian and Early Mississippian age on the western flank of the Appalachian basin is the object of increased interest as a potential source of synthetic fuels as well as oil and natural gas. This report presents a summary of the lithology and stratigraphy of cores from 10 holes drilled in Lewis and Fleming Counties, Ky., in an effort to learn more about the shale sequence. The locations of the 10 cored holes are shown on figure 1, and an east-west cross section into which graphic logs of the cores have been projected is shown in Plate 1.

The units penetrated, in order of increasing age, include the lower part of the Borden Formation (Mississippian), the organic-rich Sunbury Shale, the Berea Sandstone (in the northeastern part of the study area), the Bedford Shale, the organic-rich Ohio Shale, and the unconformity. Below the unconformity are the Bisher Limestone and the

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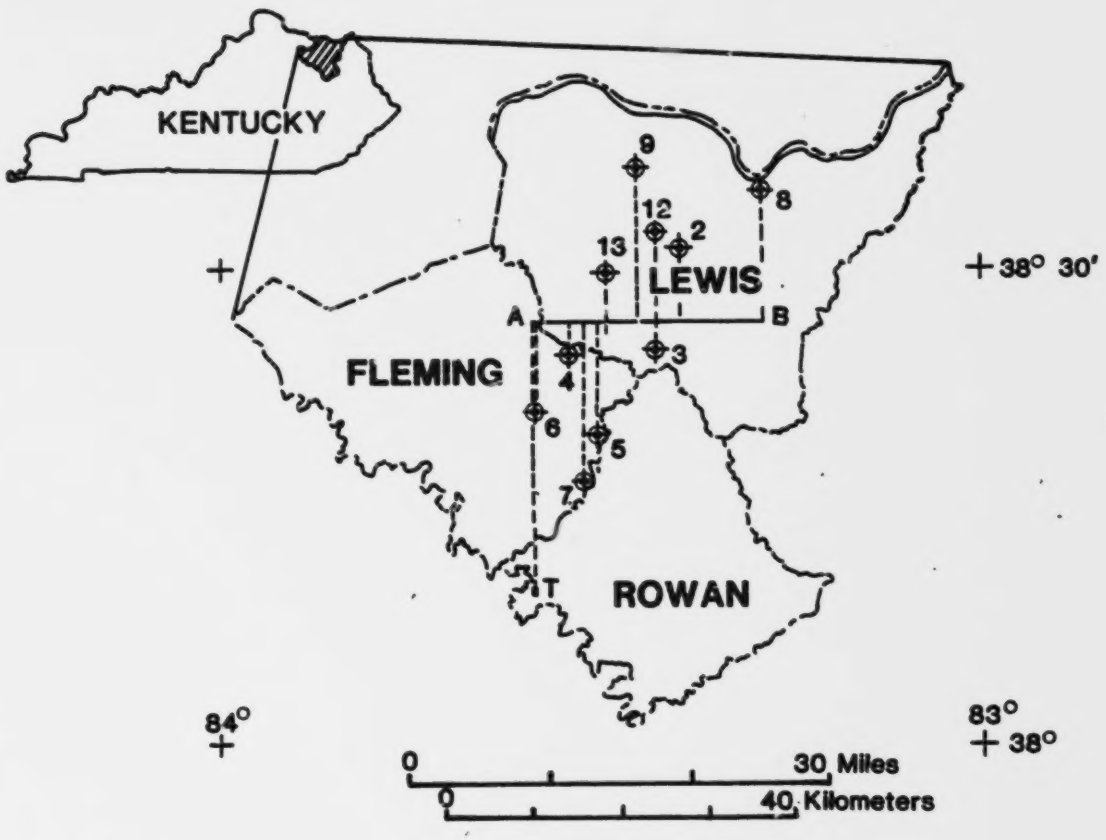

Figure 1. Map of Lewis, Fleming, and Rowan Counties, Ky., showing location of holes from which core is described in this report, the line of section A-B of plate 1, and the location (T) of the type locality of the Three Lick Bed (Provo and others, 1978).

Crab Orchard Formation, both of Silurian age. The lower part of the Bedford Shale and the Ohio Shale are Devonian. (See plate 1.)

The greatest thickness variations within the sequence are those related to the distribution of the Berea Sandstone. Where the Berea is thick, the interval between the Sunbury and the Ohio is also thick (localities 2, 3, 4, 8 and 9; fig. 1, plate 1). The Sunbury Shale in the cores ranges from 13.3 to 18.4 ft. thick; it is thinnest at locality 8, where the Berea Sandstone is thickest (76 ft.). Otherwise the depositional strike of the shale sequence is nearly north-south; near absence of exception to a uniform westward-thinning pattern is shown on the diagrammatic cross section (plate 1). Our detailed study of a small area supplements earlier regional cross sections (Wallace and others, 1977; Kepferle and others, 1978).

In the cores the Ohio Shale is 190-291 ft. thick. The Three Lick Bed divides it into the Cleveland Member, above, and the Huron Member, below. The thickness of the Cleveland ranges from 50 to 65 ft. The Three Lick Bed ranges from 11 to 18 ft. thick, although at locality 13, the distinctive lower bed cannot be identified in a sequence of thins beds of black and greenish-gray shale. In the cores studied the Huron Member of the Ohio Shale ranges in thickness from 128 to 208 ft. The Huron shows greater lithologic diversity than does the Cleveland.

Greatest lithologic variations appear in the basal part of the Huron Member, where two zones of mixed lithology are separated by a bed of black shale that ranges in thickness from 4 to 12 ft. The underlying zone of mixed lithology lies immediately above the basal unconformity and in at least two cores (localities 6 and 13) contains bone beds, which

may indicate at least two additional intraformational discontinuities. This unit may be equivalent to the upper part of the Olentangy Shale in Ohio, as used by Schwietering (1979).

The upper zone of mixed lithology occurs immediately above the basal continuous black shale bed; it is characterized by intensive bioturbation in greenish-gray shale beds, which become intermixed with the underlying black shales.

Another zone of mixed lithology is better developed in the southwesternmost cores and at the type section of the Three Lick Bed. A biostratigraphic marker that is abundant and commonly is associated with this zone is Foerstia (Protosalvinia), an alga. Variations in the thickness of the Foerstia zone may be related to the associated variations in the lithology of the zone in which it is found. The Foerstia zone is widespread in the Appalachian basin (Schopf and Schwietering, 1970; Schwietering and Neal, 1978).

Conodonts from two of the lower black shale beds have been identified by Anita G. Harris. Palmatolepis glabra glabra Ulrich & Bassler, and P. perlobata schindewolfi Muller occurs at a depth of 339.2 ft. in the core from Kep No. 2 (locality 2, fig. 1, plate 1) (10203-SD).

Conodonts identified from the same horizon in the core from Kep No. 7 (locality 7, fig. 1, plate 1) at a depth of 248.1 ft. (10202-SD) include Palmatolepis glabra Ulrich & Bassler. This same conodont was recognized in a sample from the base of the next lowest continuous black shale bed in the core of Kep No. 9 (10204-SD) (locality 9, fig. 1, plate 1); this sample also contained abundant Palmatolepis perlobata Ulrich & Bassler. All of these conodonts indicate a Famennian Age (upper

Upper Devonian) (Anita G. Harris, written communications, June 10, 1980, and June 30, 1980).

Fossils other than Foerstia and conodonts in these cores include sporomorphs (Tasmanites), woody plant material, and phosphatic brachiopods and fish remains (scales, teeth, and bone fragments), in order of decreasing abundance.

Pyrite is common in all units as microspheres, disseminated silt- to sand-sized crystals, framboids, and irregular cauliflower-shaped nodules on which the upper surface is made up of well-formed crystal facets. Phosphatic nodules were found in the basal Borden Formation, at the top of the Sunbury Shale in the core from Kep No. 4 (locality 4, fig. 1, plate 1), and in the upper part of the Cleveland Member of the Ohio Shale at the type locality of the Three Lick Bed (locality T, fig. 1, plate 1). Calcareous concretions are conspicuous locally in the lower part of the Huron Member; one occurs in Le No. 2 (locality 12, fig. 1, plate 1). Sideritic bands are common in the Bedford Shale in the core from Kep No. 8 (locality 8, fig. 1, plate 1).

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Kep No. 2
Charters Quad., Elev. 940 ft.
2770 ft. FSL X 3520 ft. FEL
Sec. 17-Y-74, Lewis Co., Ky.
Completed May 21, 1980

Depth in feet	Lithology
	Borden Formation, lower part.
0.00 - 17.00	Not cored.
17.00 - 18.00	Clay shale, dark olive-gray (5Y 3/1), calcareous.
18.00 - 18.30	Clay shale, greenish-gray (5G 5/1), glauconitic, burrowed, soft and plastic.
18.30 - 19.60	Clay shale, greenish-gray (5G 6/1) to light olive-gray (5Y 6/1), mottled, calcareous, pyritic and burrowed, glauconitic.
19.60 - 19.90	Clay shale, greenish-gray (5GY 5/1), conodonts, brachiopods, glauconitic, burrowed.
19.90	Top of Sunbury Shale.
19.90 - 34.23	Shale, black (N 1), dense, pyrite at 21.40 - 21.44 ft. Bone bed at 30.07 ft.
34.23	Top of Berea Sandstone.
34.23 - 43.42	Siltstone, light-olive-gray (5Y 6/1) to medium-gray (N 6), planar inclined bedding, no partings.
43.42 - 53.00	Siltstone, as above, and clay shale, olive-gray (5Y 4/1) to medium dark-gray (N 4). Clay shale is distributed in 11 beds detailed as follows: 43.42 - 43.45 Clay shale; 43.78 - 43.83 Clay shale; 44.11 - 44.20 Clay shale; 45.35 - 45.45 Clay shale; 45.70 - 45.82 Clay shale; 46.20 - 46.21 Clay shale; 47.50 - 47.51 Clay shale; 48.42 - 48.65 Clay shale; 49.30 - 50.10 Clay shale; 50.45 - 50.47 Clay shale; 50.70 - 50.72 Clay shale. 51.60 - 52.30 Interbedded siltstone and shale, about 50 percent each.
53.00 - 59.85	Siltstone, as above, 50 percent; clay shale, as above, 50 percent; beds less than 0.10 ft. thick.

Kep No. 2

Depth in feet	Lithology
59.85 - 61.30	Siltstone, as above; single bed.
61.30	Top of Bedford Shale.
61.30 - 62.00	Siltstone and shale, as above; beds less than 0.05 ft. thick.
62.00 - 72.00	Siltstone and shale, as above; in nearly equal proportions; less than 0.10 ft. thick, commonly less than 0.05 ft. thick; locally calcareous.
72.00 - 82.00	As above, but clay shale darkens to medium gray (N 5).
82.00 - 92.00	Clay shale (60 percent), and siltstone (40 percent), as above.
92.00 - 108.50	Clay shale (70 percent), and siltstone (30 percent) as above; oil stain in siltstone.
108.50 - 112.80	Siltstone, olive-gray (5Y 7/1), and medium-gray (N 5); slight oil stain; single bed.
112.80 - 122.55	Clay shale (70 percent) and siltstone (30 percent); clay shale is medium gray (N 5). Siltstone is in beds 0.40 ft. thick, more commonly less than 0.05 ft. thick; sideritic bands as much as 0.13 ft. thick.
122.55 - 123.45	Siltstone, as above; oil-stained.
123.45 - 127.70	Clay shale (80 percent), and siltstone (20 percent), as above, in thin laminae.
127.70 - 127.95	Shale, brownish-black (5YR 2/1).
127.95 - 129.05	Clay shale, dark-gray (N 3) to dark-greenish-gray (5G 4/1).
129.05	Top of Cleveland Member of Ohio Shale.
129.05 - 142.00	Shale, brownish-black (5YR 2/1); Lingula and Tasmanites common.
142.00 - 152.00	Shale, as above; phosphate nodule at 146.10 - 146.13 ft. is dark yellow brown (10YR 4/2), calcareous in part.
152.00 - 162.00	Shale, brownish-black (5YR 2/1), sparse calcisiltite laminae.

Depth in feet	Lithology
162.00 - 172.00	Shale, brownish-black (5YR 2/1) and olive-gray (5Y 3/1) in indistinct couplets; about 1 ft. between cycles. Calcisiltite laminae locally common.
172.00 - 182.00	Shale, banded, as above; calcisiltite laminae common.
182.00 - 187.50	Shale, banded, as above; pyrite band at base.
187.50	Top of Three Lick Bed.
187.50 - 190.00	Clay shale, greenish-gray (5GY 5/1), burrowed. Burrows extend about 0.05 ft. into unit below; pyritic.
190.00 - 194.35	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1); banded.
194.35 - 194.37	Clay shale, greenish-gray, as above.
194.37 - 195.25	Shale, brownish-black, as above.
195.25 - 196.52	Clay shale, greenish-gray, as above.
196.52 - 197.37	Shale, brownish-black, as above.
197.37 - 197.40	Clay shale, greenish-gray, as above.
197.40 - 198.86	Shale, brownish-black, as above.
198.86 - 198.87	Clay shale, greenish-gray, as above.
198.87 - 200.00	Shale, brownish-black, as above.
200.00 - 203.10	Clay shale, greenish-gray, as above. Base burrowed.
203.10	Top of Huron Member of Ohio Shale.
203.10 - 211.00	Shale, brownish-black, as above.
211.00 - 211.17	Clay shale, greenish-gray, as above; pyritic; base sharp, top may be burrowed.
211.17 - 241.00	Shale, brownish-black (5YR 2/1), obscure burrowing at 211.55 ft.; cone-in-cone limestone at 216.28 - 216.32 ft. and at 233.90 -233 .92 ft.
241.00 - 251.00	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1); contains occasional laminae (0.02 ft. thick) of dark-greenish-gray (5G 4/1) shale.

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Depth in feet	Lithology
251.00 - 271.00	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1); dark-greenish-gray beds absent. Cone-in-cone limestone at 263.55 - 263.59 ft.; zone of calcareous laminae 0.02 ft. thick at 270.19 - 270.35 ft.
271.00 - 291.00	Shale, olive-black (5Y 4/1), and abundant dark greenish-gray laminae. Cone-in-cone limestone at 278.45 - 278.50 ft.
291.00 - 308.03	Shale, brownish-black (5YR 2/1) and dark-olive-gray (5Y 3/1) in indistinct couplets in cycles about 1 ft. thick. Calcisiltite laminae increase toward base; conspicuous at 296.60 - 296.61 ft. At 297.54 - 297.58 ft. is clay shale, greenish-gray (5GY 4/1), having sharp contacts. At 301.00 ft. is a fossil eurypterid claw or fish jaw.
308.03 - 308.54	Clay shale, greenish-gray (5G4 4/1), burrowed.
308.54	Top of Foerstia zone.
308.54 - 308.58	Shale, brownish-black (5YR 2/1); contains Foerstia.
308.58 - 308.87	Clay shale, greenish-gray (5GY 4/1), burrowed.
308.87 - 308.97	Shale, brownish-black (5YR 2/1); contains Foerstia.
308.97 - 309.01	Clay shale, greenish-gray (5GY 4/1).
309.01 - 309.03	Shale, brownish-black (5YR 2/1); contains Foerstia.
309.03 - 309.05	Clay shale, greenish-gray (5GY 4/1).
309.05 - 311.50	Shale, brownish-black (5YR 2/1); contains Foerstia to base. Calcisiltite in sparse laminae; conspicuous at 309.1 ft.
311.50	Base of Foerstia zone.
311.50 - 340.63	Shale, brownish-black (5YR 2/1). Calcisiltite laminae common; abundant in distorted zone at 320.0 to 321.0 ft. where laminae resemble results of differential compaction around nearby concretion. Pyrite nodules sparse. Conodonts in thin pyrite bed at 339.32 to 339.34 ft. (USGS collection 10203-SD).

Depth in feet	Lithology
340.63 - 340.68	Clay shale, greenish-gray (5GY 4/1),burrowed and mottled; burrows extend 0.1 - 0.05 ft. into underlying dark shale unit. In description below, similar beds are referred to as "Clay shale, gray."
340.68 - 342.05	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1); calcisiltite laminae locally common; Tasmanites common. Basal contact sharp. In description below, similar beds are referred to as "Shale, black."
342.05 - 353.68	Interbedded clay shale, gray, and shale, black. Details:

342.05 - 342.10 Clay shale, gray;
342.10 - 342.34 Shale, black;
342.34 - 342.40 Clay shale, gray;
342.40 - 342.65 Shale, black;
342.65 - 342.70 Clay shale, gray;
342.70 - 343.31 Shale, black;
343.31 - 343.36 Clay shale, gray;
343.36 - 343.58 Shale, black;
343.58 - 343.95 Clay shale, gray;
343.95 - 344.18 Shale, black;
344.18 - 344.64 Clay shale, gray;
344.64 - 344.91 Shale, black;
344.91 - 344.98 Clay shale, gray;
344.98 - 346.10 Shale, black;
346.10 - 346.19 Clay shale, gray;
346.19 - 346.22 Shale, black;
346.22 - 346.32 Clay shale, gray;
346.32 - 346.55 Shale, black;
346.55 - 346.58 Clay shale, gray;
346.58 - 346.63 Shale, black;
346.63 - 346.72 Clay shale, gray;
346.72 - 347.49 Shale, black;
347.49 - 347.50 Clay shale, gray;
347.50 - 348.07 Shale, black;
348.07 - 348.18 Clay shale, gray;
348.18 - 348.35 Shale, black;
348.35 - 348.37 Clay shale, gray;
348.37 - 348.40 Shale, black;
348.40 - 348.75 Clay shale, gray;
348.75 - 348.98 Shale, black;
348.98 - 349.00 Clay shale, gray;
349.00 - 349.21 Shale, black;
349.21 - 349.28 Clay shale, gray;
349.28 - 349.30 Shale, black;
349.30 - 349.35 Clay shale, gray;
349.35 - 349.60 Shale, black;

Depth in feet	Lithology
342.05 - 353.68 (Continued)	349.60 - 349.65 Clay shale, gray;
	349.65 - 349.82 Shale, black;
	349.82 - 349.88 Clay shale, gray;
	349.88 - 350.05 Shale, black;
	350.05 - 350.06 Clay shale, gray;
	350.06 - 350.18 Shale, black;
	350.18 - 350.24 Clay shale, gray;
	350.24 - 350.84 Shale, black;
	350.84 - 350.88 Clay shale, gray;
	350.88 - 351.10 Shale, black;
	351.10 - 351.18 Clay shale, gray;
	351.18 - 351.26 Shale, black;
	351.26 - 351.41 Clay shale, gray;
	351.41 - 351.64 Shale, black;
	351.64 - 351.76 Clay shale, gray;
	351.76 - 352.27 Shale, black;
	352.27 - 352.30 Pyrite lens;
	352.30 - 353.21 Shale, black;
	353.21 - 353.23 Clay shale, gray;
	353.23 - 353.64 Shale, black;
	353.64 - 353.68 Clay shale, gray.
353.68 - 355.00	Shale, brownish-black (5YR 2/1); Tasmanites abundant.
355.00 - 355.03	Clay shale, greenish-gray (5GY 4/1); burrowed.
355.03 - 356.38	Shale, brownish-black.
356.38 - 356.99	Clay shale, greenish-gray.
356.99 - 357.48	Shale, brownish-black.
357.48 - 357.51	Clay shale, greenish-gray.
357.51 - 358.93	Shale, brownish-black.
358.93 - 358.95	Clay shale, greenish-gray.
358.95 - 359.22	Shale, brownish-black.
359.22 - 359.25	Clay shale, greenish-gray.
359.25 - 360.28	Shale, brownish-black.
360.28 - 360.32	Clay shale, greenish-gray.
360.32 - 360.55	Shale, brownish-black.
360.55 - 360.56	Clay shale, greenish-gray.

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Depth in feet	Lithology
360.56 - 361.41	Shale, brownish-black.
361.41 - 361.42	Clay shale, greenish-gray.
361.42 - 361.93	Shale, brownish-black.
361.93 - 362.00	Calcisiltite, pyrite.
362.00 - 362.40	Shale, brownish-black.
362.40 - 363.13	Clay shale, greenish-gray (5GY 4/1), burrowed.
363.13 - 363.27	Shale, brownish-black (5YR 2/1).
363.27 - 363.31	Clay shale, greenish-gray.
363.31 - 363.35	Shale, brownish-black.
363.35 - 363.64	Clay shale, greenish-gray.
363.64 - 363.67	Shale, brownish-black.
363.67 - 363.91	Clay shale, greenish-gray.
363.91 - 364.15	Shale, brownish-black.
364.15 - 364.42	Clay shale, greenish-gray.
364.42 - 364.44	Shale, brownish-black.
364.44 - 364.59	Clay shale, greenish-gray.
364.59 - 364.65	Shale, brownish-black.
364.65 - 364.77	Clay shale, greenish-gray.
364.77 - 365.37	Shale,brownish-black.
365.37 - 365.47	Clay shale, greenish-gray.
365.47 - 365.52	Shale, brownish-black.
365.52 - 366.70	Clay shale, greenish-gray.
366.70 - 366.75	Shale, brownish-black.
366.75 - 366.90	Clay shale, greenish-gray.
366.90 - 367.03	Shale, brownish-black.

Kep No. 2

Depth in feet	Lithology
367.03 - 367.14	Clay shale, greenish-gray.
367.14 - 367.40	Shale, brownish-black.
367.40 - 367.70	Clay shale, greenish-gray.
367.70 - 367.93	Shale, brownish-black.
367.93 - 367.94	Bone bed; pyritic.
367.94 - 368.79	Clay shale, greenish-gray.
368.79 - 368.80	Shale, brownish-black.
368.80 - 369.53	Clay shale, greenish-gray.
369.53 - 369.57	Shale, brownish-black.
369.57 - 369.64	Calcisiltite laminae and pyrite.
369.64 - 369.68	Shale, brownish-black.
369.68 - 370.04	Clay shale, greenish-gray (5GY 4/1), burrowed.
370.04 - 370.09	Shale, brownish-black (5YR 2/1); Tasmanites.
370.09 - 370.44	Clay shale, greenish-gray.
370.44 - 370.47	Shale, brownish-black; contains vitrinite and pyrite.
370.47 - 371.91	Clay shale, greenish-gray.
371.91 - 371.94	Shale, brownish-black; Tasmanites abundant; pyritic.
371.94 - 372.42	Clay shale, greenish-gray.
372.42 - 372.55	Bone bed, Tasmanites abundant, conodonts common.
372.55	Unconformity. Top of Bisher Limestone (Silurian).
372.55 - 389.00	Dolomite, medium-gray (N5), light-gray (N7), and medium-light-gray (N6), to light-olive-gray (5Y 6/1); finely crystalline, vuggy, oil-stained, pyritic, sparse clay in thin partings; vugs decrease with depth, are absent below 386.0 ft.
389.00	Total depth.

Kep No. 3
Stricklett Quad., Elev. 932 ft.
3250 ft. FSL X 1150 ft. FEL
Sec. 2-W-73, Lewis Co., Ky.
Completed May 12, 1980

Depth in feet	Lithology
	Borden Formation, lower part.
0 - 5.00	Not cored.
5.00 - 17.00	Siltstone (95 percent) and shale (5 percent). Siltstone is light gray (N 7) to yellowish gray (5Y 8/1), planar laminated; burrowed in upper part. Shale is medium gray (N 5), micaceous, occurs as partings as follows: 5.40 - 5.50 ft.; 7.10 - 7.50 ft.; 11.50 - 11.60 ft.; 12.30 - 12.40 ft.; 13.40 - 13.50 ft.; 15.30 - 15.60 ft..
17.00 - 33.80	Siltstone (75 percent) and shale (25 percent) as above. Siltstone removed for testing, at 17.00 - 19.00 ft. Shale partings detailed as follows: 20.20 - 20.25 Shale; 21.70 - 23.40 Shale; 24.80 - 25.60 Shale; 26.30 - 26.50 Shale; 27.90 - 28.30 Shale, with siderite; 29.20 - 29.40 Shale; 20.30 - 30.60 Shale; 32.30 - 32.70 Shale.
33.80 - 36.10	Clay shale, medium-gray (N 5).
36.10 - 39.00	Clay shale, grayish-red (5R 4/1) to grayish-brown (5YR 3/2). Sparse crinoidal debris at 38.20 ft.
39.00 - 41.00	Clay shale, medium-gray (N 5) to medium-dark-gray (N 4).
41.00 - 43.00	Removed for physical testing.
43.00 - 51.00	Clay shale, medium-dark-gray (N 4), grades down to dark gray (N 3); scattered pyrite.
51.00 - 51.60	Clay shale, medium-gray (N 5) to greenish-gray (5GY 5/1). Scattered glauconite (?) in basal 0.20 ft.

Kep No. 3

Depth in feet	Lithology
51.60	Top of Sunbury Shale.
51.60 - 57.00	Shale, black (N 1); scattered pyrite laminae.
57.00 - 59.00	Removed for physical testing.
59.00 - 68.40	Shale, black (N 1); "bone bed" at 67.92 - 67.94 ft. Basal contact sharp.
68.40	Base of Sunbury Shale. Top of Berea Sandstone.
68.40 - 81.00	Siltstone (60 percent) and shale (40 percent). Siltstone is medium light gray (N 6) to light gray (N 7); planar bedded and burrowed. Beds up to 0.8 ft. thick at top, commonly less than 0.05 ft. thick. Shale is medium dark gray (N 4) with greenish cast; partings commonly less than 0.03 ft. thick.
81.00 - 91.00	Siltstone (50 percent) and shale (50 percent), as above.
91.00	Top of Bedford Shale.
91.00 - 111.27	Shale (70 percent) and siltstone (30 percent), as above. Siderite band about every 2 ft. Sample from 103.7 - 105.7 ft. removed for physical testing. Siltstone is oil stained below 101 ft.
111.27 - 113.70	Siltstone, medium-light-gray (N 6); about half is oil stained, dark yellowish brown (10YR 4/2); bedding laminae are planar, horizontal to low angle. Single bed.
113.70 - 119.00	Clay shale and siltstone, as above, sideritic.
119.00 - 121.00	Removed for physical testing.
121.00 - 121.20	Clay shale, medium-gray (N 5).
121.20 - 121.57	Shale, brownish-black (5YR 2/1), irregular boundary.
121.57 - 121.60	Clay shale, dark-greenish-gray (5GY 4/1).
121.60 - 121.85	Shale, brownish-black, as above.
121.85 - 123.70	Clay shale, dark greenish-gray (5GY 5/1), local pyrite.

Kep No. 3

Depth in feet	Lithology
123.70	Top of Cleveland Member of Ohio Shale.
123.70 - 129.00	Shale, brownish-black (5YR 2/1), sparse calcisiltite laminae; Lingula present.
129.00 - 131.00	Removed for physical testing.
131.00 - 151.00	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1), sparse calcisiltite laminae; scattered pyrite in layers and nodules. Phosphate nodule at 139.82 - 139.85 is dark yellowish brown (10YR 3/2). Core fractured from 133.80 to 135.0 ft. Tasmanites present.
151.00 - 161.00	Shale, as above, calcisiltite laminae common in basal 1.0 ft.; scattered pyrite in layers and nodules.
161.00 - 178.79	Shale, black, as above; lighter bands are dark olive gray (5Y 3/1), in cycles about 1 ft. apart. 161.07 - 161.10 Conspicuous calcisiltite laminae; 168.45 - 168.47 Conspicuous calcisiltite laminae; 173.15 - 173.20 Calcisiltite layer.
178.79	Top of Three Lick Bed.
178.79 - 180.80	Clay shale, greenish-gray (5GY 5/1), burrowed, pyritic; burrows extend into unit below.
180.80 - 185.60	Shale, brownish-black (5YR 2/1).
185.60 - 186.80	Clay shale, greenish-gray (5GY 5/1), as above; burrowed.
186.80 - 187.35	Shale, brownish-black, as above.
187.35 - 187.40	Clay shale, greenish-gray, as above.
187.40 - 187.58	Limestone, cone-in-cone structure at top; medium-light-gray (N 6) to medium-gray (N 5).
187.58 - 189.00	Shale, brownish-black, as above.
189.00 - 189.02	Clay shale, greenish-gray, as above.
189.02 - 189.97	Shale, brownish-black, as above; pyrite-filled burrow in basal 0.05 ft.

Kep No. 3

Depth in feet	Lithology
189.97 - 192.97	Clay shale, greenish-gray, as above; burrows extend into underlying unit.
192.97	Top of Huron Member of Ohio Shale.
192.97 - 201.00	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1). Includes minor units as follows: 195.42 - 195.45 Calcisiltite lamina; 196.94 - 196.95 Calcisiltite lamina; 198.93 - 199.00 Calcisiltite lamina; 200.38 - 200.40 Clay shale, greenish-gray, as above; burrowed at top.
201.00 - 281.00	Shale, brownish-black (5YR 2/1) and lighter indistinct olive-gray (5Y 3/1) bands in cycles about 1 ft. thick. Contains minor units as follows: 211.85 - 211.90 Calcisiltite lamina; 225.50 - 225.60 Calcisiltite bed, pyritic; 231.22 - 231.25 Calcisiltite lamina; 232.65 - 232.60 Calcisiltite lamina; 246.33 - 246.36 Calcisiltite; 250.77 - 250.80 Calcisiltite; 256.50 - 256.57 Calcisiltite; 267.80 - 267.87 Cone-in-cone limestone; 280.40 - 280.42 Calcisiltite.
281.00 - 290.25	Shale, banded as above; calcisiltite laminae more abundant.
290.10	Top of Foerstia zone.
290.25 - 291.36	Clay shale, greenish-gray (5GY 4/1); pyrite-filled burrows at top.
291.36 - 291.56	Shale, brownish-black (5YR 2/1); Foerstia.
291.56 - 292.85	Clay shale, greenish-gray (5GY 4/1), burrowed.
292.85 - 293.00	Shale, brownish-black (5YR 2/1); Foerstia.
293.00 - 293.04	Calcisiltite lamina.
293.04 - 293.43	Clay shale, greenish-gray.
293.43 - 293.53	Shale, brownish-black; Foerstia.
293.53 - 293.62	Clay shale, greenish-gray.

Kep No. 3

Depth in feet	Lithology
293.62 - 293.64	Shale, brownish-black; Foerstia.
293.64 - 294.00	Clay shale, greenish-gray.
294.00 - 294.08	Shale, brownish-black; Foerstia.
294.08 - 294.50	Clay shale, greenish-gray.
294.50 - 301.00	Shale, brownish-black, as above. Calcisiltite laminae abundant.
295.35	Base of Foerstia zone.
301.00 - 311.00	Shale, brownish-black (5YR 2/1); common calcisiltite and pyritic laminae.
311.00 - 321.00	Shale, brownish-black (5YR 2/1). Calcisiltite laminae abundant: 20 per 0.10 ft.
321.00 - 322.80	Shale, brownish-black (5YR 2/1). Calcisiltite laminae abundant. Pyrite layers and lenses.
322.80 - 337.84	Clay shale and shale. Clay shale is greenish gray (5GY 4/1), burrowed, pyritic; burrows extend 0.10 ft. into unit below. Shale is brownish black (5YR 2/1), contains burrows filled with greenish-gray clay shale. Details follow:

322.80 - 322.88 Greenish-gray clay shale;
322.88 - 323.38 Black shale;
323.38 - 323.41 Greenish-gray clay shale;
323.41 - 323.60 Black shale;
323.60 - 324.07 Greenish-gray clay shale;
324.07 - 324.28 Black shale;
324.28 - 324.48 Greenish-gray clay shale;
324.48 - 324.52 Black shale;
324.52 - 324.70 Greenish-gray clay shale;
324.70 - 324.72 Black shale;
324.72 - 324.77 Greenish-gray clay shale;
324.77 - 325.22 Black shale;
325.22 - 325.28 Greenish-gray clay shale;
325.28 - 325.48 Black shale;
325.48 - 325.85 Greenish-gray clay shale;
325.85 - 326.04 Black shale;
326.04 - 326.60 Greenish-gray clay shale;
326.60 - 326.85 Black shale;
326.85 - 326.93 Greenish-gray clay shale;
326.93 - 327.00 Black shale.

Depth in feet	Lithology
322.80 - 337.84 (Continued)	327.00 - 327.08 Greenish-gray clay shale;
	327.08 - 327.99 Black shale;
	327.99 - 328.13 Greenish-gray clay shale;
	328.13 - 328.19 Black shale;
	328.19 - 328.35 Greenish-gray clay shale;
	328.35 - 328.52 Black shale;
	328.52 - 328.56 Greenish-gray clay shale;
	328.56 - 328.63 Black shale;
	328.63 - 328.72 Greenish-gray clay shale;
	328.72 - 329.38 Black shale;
	329.38 - 329.40 Greenish-gray clay shale;
	329.40 - 329.62 Black shale;
	329.62 - 329.64 Greenish-gray clay shale;
	329.64 - 329.81 Black shale;
	329.81 - 329.88 Greenish-gray clay shale;
	329.88 - 330.00 Black shale;
	330.00 - 330.06 Greenish-gray clay shale;
	330.06 - 330.08 Black shale;
	330.08 - 330.30 Greenish-gray clay shale;
	330.30 - 330.31 Black shale;
	330.31 - 330.34 Greenish-gray clay shale;
	330.34 - 330.56 Black shale;
	330.56 - 330.57 Greenish-gray clay shale;
	330.57 - 330.79 Black shale;
	330.79 - 330.85 Greenish-gray clay shale;
	330.85 - 330.86 Black shale;
	330.86 - 330.90 Greenish-gray clay shale;
	330.90 - 331.16 Black shale;
	331.16 - 331.21 Greenish-gray clay shale;
	331.21 - 331.37 Black shale;
	331.37 - 331.43 Greenish-gray clay shale;
	331.43 - 331.59 Black shale;
	331.59 - 331.66 Greenish-gray clay shale;
	331.66 - 331.76 Black shale;
	331.76 - 331.90 Greenish-gray clay shale;
	331.90 - 332.40 Black shale;
	332.40 - 332.43 Greenish-gray clay shale;
	332.43 - 332.64 Black shale;
	332.64 - 332.71 Greenish-gray clay shale;
	332.71 - 332.81 Black shale;
	332.81 - 332.92 Greenish-gray clay shale;
	332.92 - 333.11 Black shale;
	333.11 - 333.15 Greenish-gray clay shale;
	333.15 - 334.36 Black shale;
	334.36 - 334.39 Greenish-gray clay shale;
	334.39 - 334.75 Black shale;
	334.75 - 334.87 Greenish-gray clay shale;

Depth in feet	Lithology
337.84 - 343.65	Shale, brownish-black (5YR 2/1), abundant calcisiltite laminae;pyritic, occasional burrowed zones, as follows:
	335.85 - 335.87 Burrowed zone; 337.48 - 337.50 Burrowed zone; 338.36 - 338.38 Burrowed zone; 339.88 - 339.90 Burrowed zone; 341.00 - 341.03 Burrowed zone; 341.88 - 341.92 Burrowed zone; 341.92 - 342.93 Burrowed zone; 343.10 - 343.14 Burrowed zone; 343.29 - 343.30 Burrowed zone; 343.52 - 343.55 Burrowed zone.
343.65 - 347.07	Clay shale and black shale, interbedded in nearly equal amounts. Clay shale is dark greenish gray (5GY 4/1), burrowed; black shale is brownish-black (5YR 2/1). Details:
	343.65 - 344.00 Greenish-gray clay shale; 344.00 - 344.20 Black shale; 344.20 - 344.38 Greenish-gray clay shale; 344.38 - 344.65 Black shale; 344.65 - 344.75 Greenish-gray clay shale; 344.75 - 345.40 Black shale; 345.40 - 345.47 Greenish-gray clay shale; 345.47 - 345.50 Black shale; 345.50 - 345.90 Greenish-gray clay shale; 345.90 - 347.07 Black shale.
347.07	Base of Huron Member of Ohio Shale.
347.07 - 347.18	Bone bed, pyritized.
347.18 - 349.90	Clay shale, dark-greenish-gray (5GY 4/1) and occasional black-shale bands; burrowed. Details:
	347.84 - 347.86 Black shale, burrowed; 348.13 - 348.18 Black shale, burrowed; 348.35 - 348.43 Laminated, burrowed at top; 348.71 - 348.74 Black shale; 348.74 - 348.76 Black shale, burrowed; 349.00 - 349.02 Pyritized bone bed; 349.88 - 349.90 Pyritized bone bed on irregular surface.
349.90	Unconformity. Top of Bisher Limestone. (Silurian).

Kep No. 3

Depth in feet	Lithology
349.90 - 351.00	Dolomite, medium-light-gray (N 6), vugular, vugs as much as 0.2 ft. long, 0.10 ft. thick; oil stained to 353.0 ft.
351.00	Bisher Limestone (Silurian) at TD.

Kep No. 4
Burtonville Quad., Elev. 1088 ft.
2900 ft. FSL X 1600 ft. FEL
Sec. 3-W-72, Fleming Co., Ky.
Completed May 15, 1980.

Depth in feet	Lithology
	Borden Formation, lower part.
0.00 - 10.00	Not cored.
10.00 - 49.90	Siltstone (78 percent) and clay shale (22 percent), interbedded. Siltstone is yellowish gray (5Y 7/2), weathered dark yellowish orange (10YR 6/6); bedding characteristic of turbidites: planar bedding laminae, burrows prominent in upper 0.2 ft. Clay shale is pale olive (10Y 6/2) to yellowish gray (5Y 7/2) and dark yellowish orange (10YR 6/6), plastic; all somewhat weathered. Fresh clay shale is medium light gray (N 6). Detail as follows:

10.00 - 11.00	Siltstone;
11.00 - 11.15	Clay shale;
11.15 - 11.90	Siltstone;
11.90 - 12.10	Clay shale;
12.10 - 12.40	Siltstone;
12.40 - 13.30	Clay shale;
13.30 - 13.70	Siltstone;
13.70 - 14.10	Clay shale;
14.10 - 14.60	Siltstone;
14.60 - 14.80	Clay shale;
14.80 - 15.10	Siltstone;
15.10 - 16.00	Clay shale;
16.00 - 16.50	Siltstone;
16.50 - 18.10	Clay shale;
18.10 - 18.50	Siltstone;
18.50 - 18.60	Clay shale;
18.60 - 19.40	Siltstone;
19.40 - 20.00	Clay shale;
20.00 - 20.80	Siltstone;
20.80 - 22.00	Clay shale;
22.00 - 23.50	Lost core;
23.50 - 24.00	Clay shale;
24.00 - 24.50	Siltstone;
24.50 - 24.70	Clay shale;
24.70 - 25.70	Siltstone;
25.70 - 25.71	Clay shale;
25.71 - 29.00	Siltstone;
29.00 - 30.30	Clay shale, silty in basal half;
30.30 - 31.40	Siltstone;
31.40 - 31.70	Clay shale;

Kep No. 4

Depth in feet	Lithology
10.00 - 49.90 (Continued)	(Siltstone and clay shale, details continued:)
	31.70 - 34.60 Siltstone;
	34.60 - 34.80 Clay shale;
	34.80 - 35.50 Lost core;
	35.50 - 35.90 Siltstone;
	35.90 - 36.10 Clay shale;
	36.10 - 36.50 Siltstone;
	36.50 - 36.60 Clay shale;
	36.60 - 38.60 Siltstone;
	38.60 - 39.30 Clay shale;
	39.30 - 39.50 Siltstone;
	39.50 - 39.80 Clay shale;
	39.80 - 42.30 Siltstone;
	42.30 - 42.40 Clay shale;
	42.40 - 44.10 Siltstone;
	44.10 - 44.30 Clay shale;
	44.30 - 44.50 Siltstone;
	44.50 - 45.00 Clay shale;
	45.00 - 46.20 Siltstone, cross-laminae zone 0.1 ft. thick, 0.2 ft. below top;
	46.20 - 47.30 Clay shale, now medium gray (N 5);
	47.30 - 47.40 Siltstone, as above;
	47.40 - 48.00 Clay shale, as above;
	48.00 - 49.20 Siltstone, as above;
	49.20 - 49.50 Clay shale;
	49.50 - 49.90 Siltstone.
49.90 - 52.30	Clay shale, medium-gray (N 5). Siderite concretion at 51.8 - 51.9 ft.
52.30 - 54.20	Clay shale, grayish-red (10R 4/2), sparse greenish-gray (5GY 4/1) mottling.
54.20 - 62.00	Clay shale, medium-gray (N 5); bedding-plane streaks are slightly silty, straight, and 0.01 ft. thick.
62.00 - 64.20	Clay shale, medium-olive-gray (5Y 5/1); grades down to medium dark gray (N 4).
64.20 - 64.50	Clay shale, dark-greenish-gray (5G 4/1).
64.50 - 65.00	Phosphatic nodules in matrix of clay shale, as above. Phosphatic nodules are light olive gray (5Y 6/1) to light brownish gray (5YR 6/1). Flakes of dark dusky green (5G 3/2) are disseminated in the matrix.

Kep No. 4

Depth in feet	Lithology
65.00 - 65.30	Clay shale, dark-greenish-gray (5G 4/1), mottled, burrowed; burrows extend 0.30 ft. into unit below.
65.30	Top of Sunbury Shale.
65.30 - 83.70	Shale, black (N 1); grades to olive black (5Y 2/1) in basal foot, nonlaminated; pyrite in blebs and layers. Details:
	69.45 Pyrite; 69.70 Pyrite; 70.75 - 70.80 Conspicuous pyrite; 71.63 Vitrinite lens; 76.00 - 77.00 Fracture, near vertical, irregular; 79.50 - 82.00 Fracture, near vertical; 80.80 - 80.90 Conspicuous pyrite bleb.
83.70	Top of Berea Sandstone.
38.70 - 96.00	Siltstone (60 percent), and shale (40 percent). Siltstone is medium light gray (N 6); laminae are discontinuous; as much as 0.1 ft. thick and interrupted by burrowing. Shale is medium dark gray (N 4). Pyrite is very abundant in disseminated crystals.
96.00	Top of Bedford Shale.
96.00 - 104.00	Shale, medium dark gray (N 4) (60 percent), and siltstone, as above, except proportionally less (40 percent).
104.00 - 119.42	Shale and siltstone, as above except shale increases to 80 percent and siltstone diminishes to 20 percent.
	113.70 - 114.25 Conspicuous siltstone, medium-olive-gray (5Y 5/1), to medium gray (N 5) with greenish cast, micaceous.
119.42 - 121.13	Interbedded clay shale, medium-gray (N 5) and shale, grayish-black (N 2). Black shale is in thin laminae as much as 0.10 ft. thick. Proportions are black (25 percent), gray (75 percent).

Kep No. 4

Depth in feet	Lithology
121.13	Top of Cleveland Member of Ohio Shale.
121.13 - 122.10	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1); Lingula common on some bedding planes.
122.10 - 122.30	Phosphate ? nodules, medium-gray (N 5), in clay-shale matrix. Clay shale is greenish-gray (5GY 5/1); compacted around nodules.
122.30 - 146.00	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1). Laminae sparse; Tasmanites common; pyrite lenses or disseminated fine crystals along bedding planes.
	125.01 - 125.02 Conspicuous pyrite;
	126.72 - 126.75 Conspicuous pyrite;
	126.68 - 126.70 Vitrain band;
	128.00 - 135.00 Scattered fractures common;
	136.07 - 136.09 Conspicuous lens, calcareous phosphate, pyritic;
	140.30 - 140.39 Pyrite lens.
146.00 - 157.00	Black shale, as above; calcisiltite more abundant.
	148.00 - 152.00 Fracture prominent.
	152.15 - 152.18 Prominent pyrite nodule.
	154.13 - 154.20 Prominent pyrite nodule.
157.00 - 172.00	Shale, olive-black (5Y 2/1) to dark-brownish-gray (5YR 3/1) in alternating indistinct bands 0.5 - 0.8 ft. thick. Darker shale is more firm and 0.3 - 0.5 ft. thick; bands become lighter below 164.70 ft.
	163.40 - 164.3 Calcisiltite laminae common up to 0.01 ft. thick.
	167.10 - 167.50 Calcisiltite laminae common up to 0.01 ft. thick.
	167.72 - 167.78 Cone-in-cone limestone.
	168.00 - 172.00 Laminated dark-greenish-gray (5GY 4/1) in lighter bands.
172.00	Top of Three Lick Bed.
172.00 - 173.50	Clay shale, greenish-gray (5GY 5/1), darker toward base; burrowed, pyritic; burrows extend 0.20 ft. into unit below.

Kep No. 4

Depth in feet	Lithology
173.50 - 178.23	Shale, brownish-black (5YR 2/1).
	174.87 - 174.90 Cone-in-cone limestone.
	176.50 - 176.53 Greenish-gray clay shale; base sharp.
178.23 - 179.30	Clay shale, greenish-gray (5GY 4/1); burrowed; pyritic. Burrows extend 0.10 ft. into unit below.
179.30 - 184.50	Shale, brownish-black (5YR 2/1); sparse laminae; base sharp.
	181.33 - 181.36 Cone-in-cone limestone.
184.50	Top of Huron Member of Ohio Shale.
184.50 - 192.00	Shale, brownish black (5YR 2/1); calcisiltite laminae increase toward base; pyritic.
	189.33 - 189.40 Cone-in-cone limestone.
	190.00 - 190.04 Cone-in-cone limestone.
	190.14 - 191.15 Cone-in-cone limestone.
192.00 - 207.00	Shale, as above; calcisiltite laminae sparse.
	201.68 - 201.72 Cone-in-cone limestone.
	199.47 - 199.51 Pyrite in scattered blebs.
207.00 - 252.00	Shale, olive-black (5Y 2/1) to dark-brownish-gray (5YR 3/1) in alternating indistinct bands 0.5 - 0.8 ft. thick; more organic bands 0.3 - 0.5 ft. thick.
	207.60 - 207.70 Cone-in-cone limestone.
	208.45 - 208.46 Cone-in-cone limestone.
	209.13 - 209.14 Cone-in-cone limestone.
	209.58 - 209.59 Cone-in-cone limestone.
	216.35 - 216.40 Cone-in-cone limestone.
	217.39 - 217.42 Pyrite nodule.
	218.80 - 219.70 Fractured.
	220.40 - 221.50 Fractured.
	223.40 - 223.41 Cone-in-cone limestone.
	223.70 - 223.78 Cone-in-cone limestone.
	226.98 - 226.00 Cone-in-cone limestone.
	240.55 - 240.56 Cone-in-cone limestone.
	244.85 - 244.94 Cone-in-cone limestone.
	246.57 - 246.58 Cone-in-cone limestone.
	249.51 - 249.54 Cone-in-cone limestone.

Kep No. 4

Depth in feet	Lithology
252.00 - 272.00	Shale, banded, as above; calcisiltite laminae sparse; pyrite in scattered blebs.
	269.47 - 269.49 Calcisiltite.
272.00 - 273.70	Shale, as above; laminae increase in basal 0.07 ft. Foerstia at 273.45 ft.
273.45	Top of Foerstia zone.
273.70 - 273.81	Clay shale, medium-gray (N 5) to medium-greenish-gray (5G 5/1); sharp base and top.
273.81 - 282.00	Shale, brownish-black (5YR 2/1); calcisiltite laminae common.
	278.30 - 279.90 Abundant calcisiltite laminae.
276.60	Base of Foerstia zone.
282.00 - 298.78	Shale, brownish-black (5YR2/1); calcisiltite laminae abundant; pyritic.
	282.00 - 284.50 Fractured. 283.01 - 283.02 Cone-in-cone limestone. 298.56 - 298.59 Calcisiltite.
298.78 - 310.90	Interbedded clay shale and dark shale. Clay shale is greenish gray (5GY 5/1) to light olive gray (5Y 6/1); pyritic; burrowed; burrows extend to underlying unit. Organic shale is brownish black (5YR 2/1); laminae abundant; basal contact grades through interval 0.01 - 0.02 ft.; upper 0.05 - 0.2 ft. contains burrows from overlying unit. Details as follows:
	298.78 - 298.84 Clay shale, burrowed; 298.84 - 299.88 Shale, brownish-black; 299.88 - 299.95 Clay shale, greenish-gray; 299.95 - 300.18 Shale, brownish-black; 300.18 - 300.53 Clay shale, greenish-gray; 300.53 - 300.71 Shale, brownish-black; 300.71 - 300.92 Clay shale, greenish-gray; 300.92 - 300.95 Shale, brownish-black; 300.95 - 301.03 Clay shale, greenish-gray; 301.03 - 301.49 Shale, brownish-black; 301.49 - 301.52 Clay shale, greenish-gray; 301.52 - 301.64 Shale, brownish-black; 301.64 - 301.97 Clay shale with dark streaks at 301.89-301.91; 301.97 - 302.13 Brownish-black shale; 302.13 - 302.75 Greenish-gray clay shale;

Kep No. 4

Depth in feet	Lithology
298.78 - 310.90 (Continued)	302.75 - 302.97 Brownish-black shale; 302.97 - 303.14 Greenish-gray clay shale; 303.14 - 303.18 Brownish-black shale; 303.18 - 303.25 Greenish-gray clay shale; 303.25 - 303.30 Brownish-black shale; 303.30 - 303.35 Greenish-gray clay shale; 303.35 - 304.13 Black shale and calcareous laminae; 304.13 - 304.43 Greenish-gray clay shale; 304.43 - 304.60 Brownish-black shale; 304.60 - 304.63 Greenish-gray clay shale; 304.63 - 304.68 Black shale; 304.68 - 304.78 Greenish-gray clay shale; 304.78 - 305.34 Black shale, calcareous laminae; 305.34 - 305.40 Greenish-gray clay shale; 305.40 - 305.83 Black shale, calcareous laminae; pyritic 305.6 - 305.61 ft. 305.83 - 306.00 Brownish-black shale; 306.00 - 306.03 Black shale; 306.03 - 306.10 Greenish-gray clay shale; 306.10 - 306.27 Black shale; 306.27 - 306.32 Greenish-gray clay shale; 306.32 - 306.36 Black shale; 306.36 - 307.46 Greenish-gray clay shale; 307.46 - 307.67 Black shale; 307.67 - 307.70 Greenish-gray clay shale; 307.70 - 307.88 Black shale; 307.88 - 308.06 Greenish-gray clay shale; 308.06 - 308.33 Black shale; 308.33 - 308.40 Greenish-gray clay shale; 308.40 - 308.58 Black shale; 308.58 - 308.84 Greenish-gray clay shale; 308.84 - 309.40 Black shale; 309.40 - 309.47 Greenish-gray clay shale; 309.47 - 309.67 Black shale; 309.67 - 310.64 Greenish-gray clay shale; 310.64 - 310.83 Black shale; 310.83 - 310.90 Greenish-gray clay shale.
310.90 - 315.95	Shale, brownish-black (5YR 2/1), laminae sparse; pyrite disseminated along bedding planes. Details: 312.35 - 312.40 Greenish-gray clay shale, burrowed; 313.30 - 313.35 Pyrite nodule; 314.80 - 314.82 Calcareous laminae; 315.35 - 315.42 Olive-gray (5Y 4/1) burrowed zone.

Kep No. 4

Depth in feet	Lithology
315.95 - 319.22	Greenish-gray clay shale (85 percent) and brownish-black shale (15 percent) interbedded; burrowed; pyrite abundant toward base; sand grains at base. Base contact irregular.
319.22	Unconformity. Top of Bisher (?) Limestone.
319.22 - 322.00	Limestone, dolomitic, sandy, grayish-yellow (5Y 8/4); porous, stylolitic.
322.00	Total depth.

Kep No. 5
Plummers Landing Quad., Elev. 810 ft.
3000 ft. FSL X 650 ft. FEL
Sec. 1-V-72, Fleming Co., Ky.
Completed April 18, 1980

Depth in feet	Lithology
	Borden Formation, lower part.
0.00 - 3.00	Not cored.
3.00 - 8.30	Clay shale, medium-gray (N 5), very plastic and muddy; contains laminae and beds of siltstone, brownish-gray (5YR 4/1); much washout.
8.30 - 15.00	Washed out, no recovery.
15.00 - 19.45	Clay shale (more firm), medium-gray (N 5).
19.45 - 19.65	Clay shale, medium-gray (N 5), contains greenish-gray (5G 6/1) laminae.
19.65	Top of Sunbury Shale.
19.65 - 22.15	Shale, black (N 1); prominent pyrite nodule 0.53 ft. from base, 0.02 ft. thick.
22.15 - 36.81	Shale, black (N 1); contains sparse siltstone laminae and pyrite. Basal contact sharp. Details: 23.30 - 23.90 Clay shale, black (N 1), less indurated; 26.82 - 26.95 Pyrite nodule; 26.95 - 27.15 Siltstone, light-gray (N 7), laminated.
36.81	Base of Sunbury Shale, Top of Bedford Shale.
36.81 - 42.00	Shale, medium-gray (N 5) to medium-light-gray (N 6); silt laminae.
42.00 - 52.00	Clay shale, medium-gray (N 5), plastic in part; contains siltstone, medium-light-gray (N 6), as laminae, pods, and irregular blebs. Scattered pyrite nodules as much as 0.09 ft. thick.
52.00 - 62.00	Clay shale, as above; contains occasional siltstone bed 0.10 ft. thick.
62.00 - 72.00	Clay shale, as above; few siltstone beds as much as 0.6 ft. thick.

Kep No. 5

Depth in feet	Lithology
72.00	Top of Cleveland Member of Ohio Shale.
72.00 - 92.00	Shale, black (N 1) to grayish-black (N 2) and occasional laminae of olive black (5Y 2/1) (probably due to pyrite). 88.19 - 88.26 Pyrite laminae. 89.07 - 89.20 Silty band, medium-gray (N 5).
92.00 - 102.00	Shale, black (N 1) to grayish-black (N 2) and sparse medium- gray (N 5). Scattered pyrite nodules; prominent at 96.37 - 96.40 ft.
102.00 - 107.90	Shale, black (N 1) to grayish black (N 2); olive-gray (5YR 4/1) bands; occasional pyrite laminae and nodules.
107.90 - 122.00	Shale, olive-gray (5YR 4/1) to olive-black (5Y 2/1), alternating with grayish-black (N 2) to dark-gray (N 3); occasional pyrite laminae and nodules, and calcareous siltstone laminae. Pyrite nodules at 111.37, 118.40, and 119.0 ft.
122.00 - 123.67	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1), contains pyritic laminae.
123.67	Top of Three Lick Bed.
123.67 - 125.32	Shale, dark-greenish-gray (5G 4/1), burrowed; pyrite as nodules and burrow fillings. Burrows extend above and below into black shale units.
125.32 - 128.80	Shale, brownish-black (5YR 2/1).
128.80 - 128.90	Calcisiltite, cone-in-cone structure, dark-gray (N 3).
128.90 - 130.10	Shale, brownish-black (5YR 2/1).
130.10 - 131.10	Shale, dark-greenish-gray (5G 4/1), burrowed; pyrite as nodules and burrow fills. Basal contact gradational.
131.10 - 131.65	Shale, brownish-black (5YR 2/1).
131.65 - 131.70	Shale, greenish-gray (5G 4/1), burrowed. Top is irregular and burrowed.

Kep No. 5

Depth in feet	Lithology
131.70 - 133.94	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1).
133.94 - 136.49	Shale, dark-greenish-gray (5G 4/1), burrows extend into unit below.
136.49	Top of Huron Member of Ohio Shale.
136.49 - 142.00	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1).
142.00 - 177.75	Shale, olive-black (5Y 2/1) to grayish-black (N 2); obscure banding of dark-gray (N 3) in cycles 0.8 to 1.0 ft. thick. Scattered pyrite nodules. Details:
	142.19 - 142.40 Limestone, medium-dark-gray (N 4), cone-in-cone;
	150.36 - 150.40 Limestone, as above;
	153.05 - 153.14 Limestone, medium-dark-gray (N 4), cone-in-cone not visible;
	157.72 - 157.74 Limestone, as above.
	163.77 - 163.80 Pyrite band and nodules.
	166.34 - 166.42 Limestone, medium-dark-gray (N 4).
	176.07 - 176.12 Limestone, cone-in-cone, medium-to medium-dark-gray (N 5 to N 4).
177.75 - 212.00	Shale, olive-black (5Y 2/1), alternating with brownish-black (5YR 2/1). Details:
	184.09 - 184.17 Limestone, dark-gray (N 3) to grayish-black (N 2).
	189.21 - 189.23 Calcisiltite, light-gray (N 7).
	192.08 Pyrite nodule.
	192.65 - 192.80 Calcisiltite laminae.
	193.70 Pyrite nodule.
	197.15 - 197.48 Shale, dark-greenish-gray (5G 4/1), burrowed, silty.
	203.20 - 203.27 Limestone, as above.
	203.31 - 203.33 Limestone, as above.
	208.55 - 208.57 Limestone, as above.
212.00 - 222.00	Shale, olive-black (5Y 2/1), contains occasional dark-greenish-gray (5G 4/1) laminae and pyrite nodules.
	219.50 - 219.70 Limestone, medium-gray (N 5), cone-in-cone.

Kep No. 5

Depth in feet	Lithology
222.00 - 232.00	Shale, brownish-black (5YR 2/1), contains Foerstia at 226.64 ft. and below; abundant slightly calcareous siltstone laminae medium-light-gray (N 6) to light-gray (N 7), and shale, greenish-gray (5GY 4/1), burrowed.
	Details:
226.64	Top of Foerstia zone.
	228.71 - 228.79 Shale, greenish-gray; 229.31 - 229.63 Shale, greenish-gray; 229.63 - 229.66 Limestone, medium-dark-gray (N 4), irregular mottled, sharp contacts; 230.09 - 230.15 Shale, greenish-gray; 231.17 - 231.30 Shale, greenish-gray; 231.33 - 231.57 Shale, greenish-gray; 231.63 - 232.00 Shale, greenish-gray.
232.00 - 242.00	Shale, brownish-black (5YR 2/1) with abundant slightly calcareous siltstone laminae and occasional pyrite laminae. Foerstia at 232.10 ft.
232.10	Base of Foerstia zone.
	233.16 Pyrite nodule.
242.00 - 256.27	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1); abundant siltstone laminae, slightly calcareous.
	244.15 Pyrite nodule. 251.55 Pyrite nodule 0.05 ft. thick.
256.27 - 267.15	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1), and clay shale, greenish-gray (5G 4/1). Contacts irregular, with burrows above and below; some pyrite-filled.
	256.27 - 256.36 Burrowed greenish-gray clay shale. 256.50 - 256.99 Burrowed greenish-gray clay shale. 257.10 - 257.61 Burrowed greenish-gray clay shale. 257.85 - 257.92 Burrowed greenish-gray clay shale. 258.19 - 258.78 Burrowed greenish-gray clay shale.

Depth in feet	Lithology
256.27 - 267.15 (Continued)	258.94 - 259.70 Burrowed greenish-gray clay shale.
	259.87 - 260.25 Burrowed greenish-gray clay shale.
	260.28 - 261.29 Burrowed greenish-gray clay shale.
	261.45 - 261.65 Burrowed greenish-gray clay shale.
	260.89 Pyrite nodule.
	254.06 Pyrite nodule.
	262.00 - 262.04 Burrowed greenish-gray clay shale.
	262.41 - 262.57 Burrowed greenish-gray clay shale.
	262.75 - 263.05 Burrowed greenish-gray clay shale.
	263.36 - 264.20 Burrowed greenish-gray clay shale.
	264.42 - 264.50 Burrowed greenish-gray clay shale.
	264.63 - 264.90 Burrowed greenish-gray clay shale.
	265.04 - 265.17 Burrowed greenish-gray clay shale.
	265.31 - 265.50 Burrowed greenish-gray clay shale.
	266.60 - 266.69 Burrowed greenish-gray clay shale.
	267.00 - 267.15 Burrowed greenish-gray clay shale.
267.15 - 274.85	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1); abundant siltstone laminae.
274.85 - 277.80	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1), with occasional band of greenish-gray (5G 4/1) clay shale, burrowed. Details:
	274.85 - 275.00 Burrowed greenish-gray clay shale;
	275.60 - 275.88 Burrowed greenish-gray clay shale;
	276.05 - 277.37 Burrowed greenish-gray clay shale.
277.80	Unconformity. Top of Bisher Limestone (Silurian).
277.80 - 285.73	Dolomite, light- to medium-gray (N 7 to N 6), very pyritic, recrystallized; traces of vugular porosity.

Kep No. 5

Depth in feet	Lithology
285.73 - 291.00	Dolomite, brownish-gray (5YR 5/1) to greenish-gray (5GY 5/1); argillaceous in greenish-gray part, nodular to pelletal.
291.00	Total depth.

Kep No. 6
Plummers Landing Quad., Elev. 1100 ft.
5400 ft. FSL X 225 ft. FEL
Sec. 21-W-71, Fleming Co., Ky.
Completed May 6, 1980

Depth in feet	Lithology
	Borden Formation, lower part
0.00 - 7.00	Not cored
7.00 - 18.60	Siltstone (85 percent) and clay shale (15 percent). Siltstone is yellowish gray (5Y 8/1), stained by weathering. Fresh siltstone is light gray (N 7). Clay shale is medium gray (N 5), stained by weathering to dark yellowish range (10YR 6/6) Clay shale, medium-dark-gray (N 5) to greenish-gray (5G 5/1) in indistinct alternating bands 0.2 - 0.8 ft. thick. Details: 29.60 - 19.95 Siltstone band; 21.10 - 21:20 Calcareous nodule; 22.90 - 23.00 Calcareous nodule.
27.00	Top of Sunbury Shale.
27.00 - 44.60	Shale, black (N 1) to grayish-black (N 2). Sparse calcisiltite laminae. Sharp planar base. Details: 29.97 - 30.00 Pyrite lense; 30.56 - 30.58 Pyrite lense; 31.05 - 31.10 Pyrite nodule; 34.02 - 34.04 Pyrite nodule; 36.50 - 36.55 Pyrite nodule; 37.20 - 37.56 Angled fracture; 38.20 - 39.20 Angled fracture; 41.00 Conodont layer.
	Base of Sunbury Shale; top of Bedford Shale.
41.45 - 51.00	Clay shale (60 - 80 percent) and siltstone (20 - 40 percent). Clay shale is medium dark gray (N 4). Siltstone is medium light gray (N 6) in beds to 0.10 ft. thick, commonly discontinuous, and interrupted by burrows. Pyrite locally abundant (as much as 20 percent).

Depth in feet	Lithology
51.00 - 61.00	Clay shale and siltstone, as above; siltstone decreases to less than 20 percent; pyrite locally abundant. Details:
	56.40 - 56.45 Siderite nodule, light-olive-gray (5Y 6/1);
	60.40 - 60.50 Siderite nodule, light-olive-gray (5Y 6/1).
61.00 - 71.00	Clay shale and siltstone, as above; pyritic; siltstone (less than 10 percent) slightly increases toward base. Sideritic zone about every 2 ft. as much as 0.10 ft. thick.
	68.10 - 68.20 Shale, brownish-black (5YR 2/1).
	70.60 - 70.90 Shale, brownish-black (5YR 2/1).
71.15	Top of Cleveland Member of Ohio Shale.
71.15 - 91.00	Shale, brownish-black (5YR 2/1); locally pyritic.
	72.60 - 72.67 Clay shale, greenish-gray (5GY 5/1), planar top; irregular, sharp base.
	76.07 - 76.09 Pyrite.
	80.43 - 80.46 Pyrite.
	80.88 - 80.89 Pyrite.
	89.17 - 89.20 Cone-in-cone limestone.
91.00 - 101.00	Shale, brownish-black (5YR 2/1); sparse calcisiltite laminae.
	100.20 - 100.30 Prominent pyrite nodule.
101.00 - 111.00	Shale, brownish-black (5YR 2/1); subtly banded with dark-gray (N 3) in alternating cycles 0.8 to 0.5 ft. thick; calcisiltite laminae increase.
	101.60 - 101.80 Elaborate cone-in-cone limestone layer.
	105.54 - 105.56 Pyrite.
	105.82 - 105.87 Pyrite.
	109.80 - 109.83 Pyrite.

Kep No. 6

Depth in feet	Lithology
111.00 - 121.05	Shale, brownish-black (5YR 2/1); calcisiltite laminae increase toward base; pyritic.
	112.86 - 112.88 Cone-in-cone limestone.
	117.33 - 117.45 Cone-in-cone limestone.
121.05	Top of Three Lick Bed
121.05 - 122.35	Clay shale, greenish-gray (5GY 5/1), pyritic, burrowed.
122.35 - 126.95	Shale, brownish-black (5YR 2/1).
126.95 - 127.85	Shale, greenish-gray (5GY 5/1); base slightly burrowed; pyritic.
127.85 - 130.36	Shale, brownish-black (5YR 2/1).
	128.38 - 128.40 Greenish-gray (5GY 5/1) clay shale.
130.36 - 132.60	Clay shale, greenish-gray (5GY 5/1), burrowed; burrows extend 0.05 ft. into underlying unit.
132.60	Top of Huron Member of Ohio Shale.
132.60 - 141.00	Shale, brownish-black (5YR 2/1). Details:
	133.33 - 133.52 Cone-in-cone limestone;
	136.77 - 136.88 Cone-in-cone limestone;
	139.00 - 139.05 Cone-in-cone limestone;
	137.95 - 137.97 Clay shale, greenish-gray, burrowed.
141.00 - 181.00	Shale, brownish-black (5YR 2/1). Calcisiltite sparse.
	151.23 - 151.25 Cone-in-cone limestone, ragged;
	153.93 - 153.95 Cone-in-cone limestone;
	156.56 - 156.57 Cone-in-cone limestone;
	159.55 - 159.59 Cone-in-cone limestone;
	167.93 - 167.98 Cone-in-cone limestone.
181.00 - 211.00	Shale, brownish-black (5YR 2/1); indistinct lighter banding, dark-gray (N 3), in cycles 0.8 - 1.0 ft. thick.
	186.33 - 186.37 Cone-in-cone limestone.
	195.65 - 195.70 Cone-in-cone limestone.

Depth in feet	Lithology
181.00 - 211.00 (Continued)	202.31 - 202.32 Pyrite and cone-in-cone layer; scattered pyrite nodules below; 203.43 - 203.46 Cone-in-cone limestone; 207.14 - 207.17 Cone-in-cone limestone.
214.03	Top of Foerstia zone.
211.00 - 216.53	Shale, as above. Foerstia abundant 0.03 ft. above base.
216.53 - 216.56	Clay shale, dark-greenish-gray (5GY 3/1).
216.56 - 231.00	Shale, brownish-black (5YR 2/1); sparse calcisiltite laminae. Calcisiltite laminae increase downward, locally 10 in 0.10 ft. Pyrite in layers and lenses 1 to 2 per ft, commonly 0.01 - 0.03 ft. thick.
218.70	Base of Foerstia zone.
231.00 - 252.13	Clay shale and black shale. Clay shale is dark greenish gray (5GY 4/1), burrowed. Shale is brownish-black (5YR 2/1). Detailed below:
	240.64 - 240.78 Greenish-gray clay shale; 240.78 - 240.97 Black shale; 240.97 - 241.00 Greenish-gray clay shale; 231.30 - 232.50 Near vertical fracture; 241.00 - 241.35 Greenish-gray clay shale; burrow extends 0.05 - 0.10 ft. into underlying unit; 241.35 - 241.56 Black shale; 241.56 - 241.88 Greenish-gray clay shale; 241.88 - 242.28 Black shale; 242.28 - 242.35 Greenish-gray clay shale; 242.51 - 242.51 Black shale; 241.51 - 242.97 Greenish-gray clay shale; 242.97 - 243.12 Black shale; 243.12 - 243.58 Greenish-gray clay shale; 243.58 - 243.79 Black shale; 243.79 - 244.05 Greenish-gray clay shale; 244.05 - 244.89 Black shale; 244.89 - 245.03 Greenish-gray clay shale; 245.03 - 245.05 Black shale; 245.05 - 245.21 Greenish-gray clay shale; 245.21 - 245.33 Black shale; 245.33 - 245.38 Greenish-gray clay shale; 245.38 - 245.42 Black shale;

Depth in feet	Lithology
231.00 - 252.13 (Continued)	245.42 - 245.50 Greenish-gray clay shale; 245.50 - 245.98 Black shale; 245.98 - 246.01 Greenish-gray clay shale; 246.01 - 246.41 Black shale; 246.41 - 246.59 Greenish-gray clay shale; 246.59 - 246.76 Black shale; 246.76 - 247.52 Greenish-gray clay shale; 247.52 - 247.93 Black shale; 247.93 - 248.07 Greenish-gray clay shale; 248.07 - 248.33 Black shale; 248.33 - 248.55 Greenish-gray clay shale; 248.55 - 248.75 Black shale; 248.75 - 249.73 Greenish-gray clay shale; 249.73 - 249.93 Black shale; 249.93 - 252.13 Greenish-gray clay shale.
252.13 - 257.49	Shale (93 percent), brownish-black (5YR2/1), and clay shale (7 percent), greenish-gray. Tasmanites abundant locally. 252.57 - 252.61 Greenish-gray clay shale. 252.71 - 252.82 Greenish-gray clay shale. 254.23 - 254.38 Greenish-gray clay shale. 257.06 - 257.10 Greenish-gray clay shale.
257.49 - 260.43	Clay shale (95 percent), dark-greenish-gray (5GY4/1); indistinct layers of brownish-black shale (5 percent), less than 0.05 ft. thick, and "trash" zones pyritized, fossiliferous at: 258.33 - 258.37 Pyritized bone bed, fossiliferous; 260.03 - 260.07 Pyritized bone bed, fossiliferous; 260.41 - 260.43 Pyritized bone bed, fossiliferous; quartzose and phosphatic.
260.43	Unconformity. Top of Crab Orchard Formation (Silurian).
260.43 - 279.00	Shale (95 percent) and dolomitic siltstone (5 percent). Shale is dolomitic, greenish gray (5GY 5/1); disseminated pyrite; more fissile than overlying Devonian shale. Dolomitic siltstone is pale to moderate brown (5YR 4/1), in beds 0.01 - 0.10 ft. thick; contains burrows extending from shale both above and below.
279.00	Total depth.

Kep No. 7
Plummers Landing Quad., Elev. 884 ft.
2900 ft. FSL X 750 ft. FEL
Sec. 19-V-72, Fleming Co., Ky.
Completed April 23, 1980

Depth in feet		Lithology
		Borden Formation, lower part.
0.00 -	10.00	Not cored.
10.00 -	10.14	Undescribable mud, surface-weathered.
10.14 -	10.36	Siltstone, medium-light-gray (N 6) to medium-gray (N 7); some iron staining.,
10.36 -	12.00	Clay shale, light-gray (N 7), very plastic.
12.00 -	17.81	Clay shale, as above, grading downward to a bluish gray (5B 6/1). At the base the color is greenish gray (5G 5/1); glauconitic; contorted, irregularly laminated.
	17.81	Top of Sunbury Shale
17.81 -	35.65	Shale, black (N 1) to brownish-black (5YR 2/1); scattered pyrite blebs and laminations more prevalent toward the base; pyrite band at 23.31 - 23.35 ft.; pyrite nodule at 28.65 ft.
	35.65	Base of Sunbury Shale. Top of Bedford Shale.
35.65 -	52.00	Shale, medium-light-gray (N 6) to medium-bluish-gray (5B 5/1), and bands and stringers of medium-light-gray (N 6) siltstone. Section is heavily pyritic (about 5 percent) as bands and blebs.
52.00 -	62.00	Shale, as above, less silty with dark-gray (N 3) bands increasing downward; grades from medium gray (N 5) to medium dark gray (N 4) towards the base; no visible pyrite.
62.00 -	63.27	Shale, dark-greenish-gray (5GY 4/1) to grayish-greenish-black (5G 2/1); some core loss in interval.
63.27 -	63.44	Shale, black (N 1), containing dark-gray (N 3) laminations.
63.44 -	64.30	Shale, dark-greenish-gray (5GY 4/1), as above, with black (N 1) laminations and streaks.
	64.30	Top of Cleveland Member of Ohio Shale.

Kep No. 7

Depth in feet	Lithology
64.30 - 65.73	Shale, black (N 1) to brownish-black (5YR 2/1); scattered disseminated pyrite throughout.
65.73 - 65.98	Shale, dark-greenish-gray (5GY 4/1); burrowed.
65.98 - 82.00	Shale, black (N 1), brownish-black (5YR 2/1), to olive-black (5Y 2/1); scattered large pyritic nodules and wavy pyrite laminae. Pyrite nodule 0.05 ft. thick at 72.30 ft.
	73.35 - 73.60 Clay shale, dark-greenish-gray (5GY 4/1); burrowed.
	74.00 - 74.05 Pyrite band.
	80.30 - 80.40 Pyrite band.
	81.70 - 81.80 Phosphate nodule?
82.00 - 92.00	Shale, olive-black (5Y 2/1) to brownish-black (5YR 2/1). Occasional greenish-gray (5GY 6/1) bands, as much as 0.05 ft. thick, slightly calcareous, are due to pyritic material. No burrows.
92.00 - 102.00	Shale, as above; pyrite bands more prominent. Scattered nodules of pyrite at top.
	94.39 - 94.50 Limestone, medium-gray (N 5) to dark-gray (N 4), cone-in-cone, argillaceous, silty.
102.00 - 112.00	Shale, brownish-black (5YR 2/1) to dark-gray (N 3); calcareous siltstone laminae increase downward in core; occasional pyrite nodules.
112.00 - 118.20	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1 dry); Tasmanites present; Laminae, less than 1 mm thick, common. Details:
	112.23 - 112.27 Cone-in-cone limestone layer, pyritic.
	113.55 - 113.56 Cone-in-cone limestone layer.
	114.18 - 114.19 Cone-in-cone limestone layer.
	115.05 - 115.07 Pyrite bleb.
	116.82 - 116.86 Cone-in-cone limestone layer, pyritic.
118.20	Top of Three Lick Bed.

Depth in feet	Lithology
118.20 - 119.58	Clay shale, dark-greenish-gray (5GY 4/1), burrowed, mottled; burrows are pyritic, extend 0.10 ft. below base into underlying dark shale. Top of bed pyritic and gradational; may be burrowed.
119.58 - 124.36	Shale, olive-black (5Y 2/1) to brownish-black (5YR 2/1). Calcareous laminae more abundant toward base; base grades over 0.03 ft.
	120.85 Lens of pyritic cone-in-cone limestone.
	121.44 - 121.47 Pyritic cone-in-cone limestone.
	123.14 - 123.16 Limestone lens, cone-in-cone.
124.36 - 125.36	Clay shale, greenish-gray (5GY 4/1), mottled and pyritic, burrows extend to 125.45 ft.
125.36 - 125.87	Shale, black, as above.
125.87 - 125.91	Clay shale, greenish-gray (5GY 4/1), mottled and pyritic, burrows extend to 125.45 ft.
125.91 - 128.00	Shale, olive-black (5Y 2/1) to brownish-black (5YR 2/1); base grades over 0.03 ft.; pyritic.
128.00 - 130.33	Clay shale, dark-greenish-gray (5GY 4/1); burrowed; burrows extend to 130.47 ft.
	129.40 - 129.42 Pyrite lens.
130.33	Top of Huron Member of Ohio Shale.
130.33 - 152.00	Shale, olive-black (5Y 2/1) to brownish-black (5YR 2/1). Alternates in cycles about 1 ft. thick with obscure bands of dark-olive-gray (5Y 3/1) shale. Calcareous pyritic laminae. Details:
	131.47 Calcareous lamina;
	131.70 - 131.74 Cone-in-cone limestone, medium-dark-gray (N 4);
	134.33 - 134.43 Cone-in-cone limestone;
	139.56 - 139.58 Cone-in-cone limestone lens;
	143.54 Calcareous laminae, silty;
	147.05 - 147.06 Calcareous laminae, silty;
	148.30 - 148.31 Calcareous laminae, silty;
	150.47 - 150.48 Calcareous laminae, silty.

Depth in feet	Lithology
152.00 - 162.00	Shale, banded, as above; layers more pyritic than calcareous. Pyrite in laminae and as scattered crystals. Details:
	152.63 - 152.65 Conspicuous lamina, calcisiltite and pyrite;
	152.62 - 152.63 Conspicuous lamina, calcisiltite and pyrite;
	156.76 - 156.77 Conspicuous lamina, calcisiltite and pyrite;
	158.58 - 158.60 Conspicuous lamina, calcisiltite and pyrite;
	161.67 - 161.68 Conspicuous lamina, calcisiltite and pyrite;
	159.22 - 159.23 Cone-in-cone limestone.
162.00 - 182.00	Shale, banded as above; scattered calcareous and pyritic laminae and cone-in-cone layers:
	164.70 - 164.73 Calcareous cone-in-cone layer;
	164.79 - 164.81 Calcareous cone-in-cone layer;
	167.35 - 167.40 Calcareous cone-in-cone layer;
	171.41 - 171.49 Calcareous cone-in-cone layer;
	181.73 - 181.79 Cone-in-cone prominent;
	181.33 Vitrinite lamina 1 mm thick;
	180.22 - 180.24 Disseminated pyrite layer.
182.00 - 202.00	Shale, as above; density appears to increase toward base.
	185.30 - 185.32 Cone-in-cone layer.
	188.86 - 188.92 Cone-in-cone layer.
	189.77 - 189.80 Cone-in-cone layer.
	184.65 Vitrinite lens.
	197.31 - 197.33 Cone-in-cone limestone layer.
	201.63 - 201.65 Pyrite concentration.
202.00 - 212.00	Shale, banded as above; abundant Tasmanites; sparse calcisiltite laminate; scattered pyrite as laminations and blebs.
212.00 - 216.45	Shale, banded, as above.
216.20	Top of Foerstia zone.

Depth in feet	Lithology
216.45 - 222.00	Alternating clay shale, dark-greenish-gray (5GY 4/1), and shale, olive-black (5Y 2/1) to brownish-black (5YR 2/1). Black shale contains Foerstia. Details:
	216.45 - 217.27 Greenish-gray clay shale; burrowed base and top sharp;
	217.27 - 217.78 Black shale; Foerstia;
	217.78 - 218.21 Greenish-gray clay shale; sharp top and base;
	218.21 - 218.43 Black shale; Foerstia;
	218.43 - 218.90 Greenish-gray clay shale, as above;
	218.90 - 219.57 Black shale; Foerstia;
	219.57 - 220.10 Greenish-gray clay shale;
	220.10 - 220.25 Black shale; Foerstia;
	220.25 - 220.57 Greenish-gray clay shale;
	220.57 - 220.59 Black shale; Foerstia;
	220.59 - 221.21 Greenish-gray clay shale;
	221.21 - 221.36 Black shale; Foerstia;
	221.36 - 221.91 Greenish-gray clay shale;
	221.91 - 222.00 Black shale; Foerstia.
222.00 - 224.35	Clay shale, greenish-gray, (90 percent), as above, and occasional laminae of black shale (10 percent), as above. Black shale contains Foerstia.
224.35 - 232.00	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1). Calcareous siltstone laminae common, 1 to 10 per 0.10 ft. Pyrite and Tasmanites abundant.
226.15	Base of Foerstia zone.
232.00 - 248.15	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1), as above. Calcisiltite laminae common; 2 to 10 per 0.1 ft. Vertical fracture extends from 232.60 to 248.15 ft.; locally mineralized with clear calcite. Layer containing abundant conodonts at 248.10 ft.
248.15 - 257.75	Interbedded clay shale, dark-greenish-gray (5GY 4/1), burrowed at base, and shale, brownish-black (5YR 2/1). Detailed as follows:
	248.15 - 248.65 Clay shale, dark greenish-gray (5GY 4/1) to greenish-gray (5G 5/1); burrows extend 0.05 ft. into unit below;

Depth in feet		Lithology
248.15 - 257.75 (Continued)	248.65 - 248.75	Shale, brownish-black; burrow at top. Basal contact sharp;
	248.75 - 248.88	Greenish-gray clay shale;
	248.88 - 248.93	Clay shale, mottled olive-gray (5Y 4/1) and greenish-gray (5GY 4/1);
	248.93 - 249.19	Greenish-gray clay shale;
	249.19 - 249.45	Olive-black shale; calcisiltite lamina in middle;
	249.45 - 249.55	Greenish-gray clay shale;
	249.55 - 249.70	Olive-black shale;
	249.70 - 250.23	Greenish-gray clay shale;
	250.23 - 250.25	Black shale;
	250.25 - 250.30	Greenish-gray clay shale;
	250.30 - 250.45	Black shale;
	250.45 - 250.95	Greenish-gray clay shale;
	250.95 - 251.13	Black shale;
	251.13 - 251.40	Greenish-gray clay shale;
	251.40 - 251.85	Black shale;
	251.85 - 252.05	Greenish-gray clay shale;
	252.05 - 252.18	Black shale;
	252.18 - 252.21	Greenish-gray clay shale;
	252.21 - 252.28	Black and burrowed shale;
	252.28 - 252.34	Greenish-gray clay shale;
	252.34 - 252.59	Black shale;
	252.59 - 252.60	Greenish-gray clay shale;
	252.60 - 252.90	Black shale;
	252.90 - 252.98	Greenish-gray clay shale;
	252.98 - 253.06	Black shale, highly burrowed;
	253.06 - 253.13	Black shale, not burrowed;
	253.13 - 253.17	Greenish-gray clay shale;
	253.17 - 253.18	Black shale;
	253.18 - 253.52	Greenish-gray clay shale;
	253.52 - 253.72	Black shale;
	253.72 - 253.90	Greenish-gray clay shale;
	253.90 - 253.95	Black shale;
	253.95 - 254.05	Greenish-gray clay shale;
	254.05 - 254.12	Black shale;
	254.12 - 254.22	Greenish-gray clay shale;
	254.22 - 254.30	Black shale;
	254.30 - 254.42	Greenish-gray clay shale;
	254.42 - 254.48	Black shale;
	254.48 - 254.62	Greenish-gray clay shale;
	254.62 - 254.96	Black shale;
	254.96 - 255.03	Greenish-gray clay shale;
	255.03 - 255.22	Black shale;
	255.22 - 256.00	Greenish-gray clay shale;
	256.00 - 256.14	Black shale;
	256.14 - 256.42	Greenish-gray clay shale;
	256.42 - 256.57	Black shale;
	256.57 - 256.65	Greenish-gray clay shale;
	256.65 - 257.73	Black shale, pyrite at 257.36 - 257.40 ft.;
	257.73 - 257.75	Greenish-gray clay shale.

Depth in feet	Lithology
257.75 - 265.07	Shale, olive-black (5Y 2/1) to brownish-black (5YR 2/1); pyrite laminae abundant as disseminated silt-size crystals. Tasmanites common. Sparse, thin beds of greenish-gray (5GY 4/1) clay shale, burrowed. Details:
	258.00 - 258.10 Greenish-gray clay shale; 262.52 - 262.55 Greenish-gray clay shale; 263.77 - 264.00 Greenish-gray clay shale; 264.20 - 264.22 Greenish-gray clay shale; 264.73 - 264.79 Greenish-gray clay shale; Base is irregular, pyritic, sharp.
265.07	Base of Ohio Shale.
265.07 - 268.45	Clay shale, greenish-gray (5GY 4/1), and occasional olive-black shale (5Y 2/1), laminated, burrowed. Details:
	265.80 - 265.93 Black shale, burrowed at top and bottom; 266.63 - 266.78 Black shale, as above; 267.25 - 267.37 Black shale; 267.80 - 267.88 Black shale; 268.00 - 268.45 Black shale, burrows contain greenish-gray to olive-gray (5Y 4/1) clay shale; highly pyritic. Base sharp, slightly irregular.
268.45	Unconformity. Top of Bisher Limestone (Silurian).
268.45 - 278.00	Dolomitic mudstone, medium-greenish-gray (5GY 5/1); dolomitized carbonate mud or sand. Locally vugular and oil stained; pyritic. Brecciated interval at 271.0 - 272.0 ft. Rare light-gray (N 7) clayey siltstone partings. Details:
	272.73 - 272.76 Siltstone lamina; 273.45 - 273.92 Siltstone lamina; 274.28 - 274.34 Siltstone lamina; 274.73 - 274.78 Siltstone lamina; 274.80 - 274.87 Siltstone lamina; 275.09 - 275.15 Siltstone lamina; 275.96 - 276.00 Siltstone lamina.
278.00	Total depth.

Kep No. 8
Vanceburg Quad., Elev. 890 ft.
5800 ft. FSL X 1600 ft. FEL
Sec. 3-Y-75 Lewis Co., Ky.
Completed May 26, 1980.

Depth in feet		Lithology
		Borden Formation, lower part.
0.00 -	15.00	Not cored.
15.00 -	15.20	Siltstone, light-gray (N 7).
15.20 -	20.00	No core.
20.00 -	20.40	Clay shale, greenish-gray (5GY 4/1) to medium-gray (N 5); slightly silty, plastic.
20.40 -	32.30	Clay shale, greenish-gray (5GY 5/1) to medium-dark-gray (N 4), with yellowish-brown (10YR 3/1) and grayish-red (5YR 4/1) bands and streaks, about 40 percent between 21.60 and 26.60 ft. Siderite band, olive-gray (5Y 5/1), dense, between 27.4 ft. and 27.50 ft.; scattered pyrite; burrowed, irregular base.
32.30 -	39.90	Siltstone, light-olive-gray (5Y 6/1), micaceous, burrowed; obscure planar bedding; Zoophycos in upper 0.5 ft.
39.90 -	40.30	Clay shale, medium-dark-gray (N 4) to greenish-gray (5GY 5/1); highly burrowed.
40.30 -	41.80	Clay shale, dolomitic and glauconitic, light greenish-gray (5GY 7/1); pyritic, nodular, burrowed, dolomitic.
41.80 -	42.00	Clay shale, greenish-gray (5GY 5/1), grades to unit below; burrows extend into underlying unit.
	42.00	Top of Sunbury Shale.
42.00 -	55.30	Shale, black (N 1) to brownish-black (5YR 2/1); sparse laminae of scattered pyrite and siltstone; bone bed containing conodonts and linguloid fragments 0.10 foot above base. Base irregular but sharp.
	55.30	Top of Berea Sandstone.
55.30 -	65.20	Siltstone, light-gray (N 7); low-angle crossbeds, bedding plane partings at 56.30 ft., 56.60 ft., 57.0 ft., 60.7 ft.; highly burrowed from 55.3 to 56.3 ft. Fragments of brachiopods at 55.90 ft. Pyrite nodule at 56.4 - 56.55 ft.
	61.30	Parting.
	61.40	Parting.

Depth in feet		Lithology
55.30 - 65.20 (Continued)	62.40	Parting.
	64.60	Parting.
65.20 - 121.00	Siltstone (70 percent) and clay shale (30 percent). Siltstone is light-gray (N 7), planar bedded to lenticular and burrowed in beds less than 0.20 ft. thick; oil stained in part. Clay shale is medium gray (N 5) to medium light gray (N 6), irregularly burrowed and pyritic, generally less than 0.05 ft. thick.	
	73.60 - 74.80	Siltstone bed.
	80.40 - 81.00	Siltstone bed.
	86.90 - 88.80	Siltstone bed; oil stained; calcareous cement and argillaceous in basal 0.01 ft.
	89.00 - 89.50	Siltstone bed; oil stained, calcareous cement and argillaceous at basal 0.01 ft.
	91.50 - 92.80	Siltstone bed, as above; stained is olive gray (5Y 6/1); unstained part is light gray (N 6).
	97.40 - 97.70	Siltstone bed, as above; stained.
	98.10 - 101.00	Siltstone bed, as above; stained.
	101.00 - 102.00	Siltstone bed, oil-stained.
	102.90 - 103.70	Siltstone bed, oil-stained.
	105.70 - 108.00	Siltstone bed, oil-stained.
	109.40 - 110.20	Siltstone bed, oil-stained.
	111.80 - 112.30	Siltstone bed, oil-stained.
	113.50 - 114.50	Siltstone bed, oil-stained.
	116.00 - 116.70	Siltstone bed, oil-stained.
	119.30 - 119.60	Siltstone bed, oil-stained.
	120.30 - 121.00	Siltstone bed, oil-stained.
121.00 - 131.00	Oil-stained siltstone (90 percent) and clay shale (10 percent), as above. Clay shale is detailed as below:	
	121.20 - 121.50	Clay shale and siltstone intermixed.
	123.00 - 123.20	Clay shale and siltstone intermixed.
	125.40 - 125.50	Clay shale and siltstone intermixed.
	128.60 - 128.70	Clay shale and siltstone intermixed.
	129.20 - 129.30	Clay shale and siltstone intermixed.
	130.60 - 130.65	Clay shale and siltstone intermixed.

Depth in feet	Lithology
131.00	Top of Bedford Shale.
131.00 - 151.00	As above, oil-stained siltstone (50 percent) and clay shale (50 percent). Scattered thin siderite bands less than 0.10 ft. thick below 141 ft.
	131.70 - 131.90 Oil-stained siltstone. 133.60 - 133.90 Oil-stained siltstone. 134.40 - 134.90 Oil-stained siltstone. 135.10 - 135.90 Oil-stained siltstone. 136.90 - 137.20 Oil-stained siltstone. 137.50 - 137.70 Oil-stained siltstone. 138.80 - 143.20 Oil-stained siltstone. 145.50 - 145.70 Siltstone, not stained. 146.40 - 147.00 Siltstone, oil-stained. 147.60 - 147.90 Siltstone, oil-stained. 148.30 - 148.50 Siltstone, oil-stained. 148.60 - 148.90 Siltstone, oil-stained. 149.90 - 150.40 Siltstone, oil-stained.
151.00 - 161.00	As above, siltstone in thinner beds.
	151.00 - 151.90 Siltstone, oil-stained. 152.60 - 152.90 Siltstone, oil-stained. 153.20 - 154.60 Siltstone, oil-stained. 155.40 - 156.10 Siltstone, oil-stained. 159.80 - 160.60 Siltstone, oil-stained, pyrite in base.
161.00 - 171.00	Predominantly shale (80 percent) and siltstone (20 percent); otherwise as above. Siderite band about every 2 ft. Shale, darker: medium dark gray (N 4).
	164.80 - 165.00 Siltstone bed, very light stain. 166.20 - 166.60 Siltstone bed, very light stain. 170.10 - 170.40 Siltstone bed, very light stain.
171.00 - 171.50	Clay shale, medium-gray (N 5) to greenish-gray (5GY 5/1); linguloid fragments; burrows extend 0.1 ft. below base; dark greenish-gray 0.10 ft. above base.
171.50	Top of Cleveland Member of Ohio Shale.
171.50 - 181.00	Shale, olive-black (5Y 2/1), Lingula and rhombic fish scales concentrated at 179.00 ft.

Depth in feet	Lithology
181.00 - 191.00	Shale, as above; pyrite accumulates along bedding, eight such layers in 10 ft.
191.00 - 201.00	Shale, black, as above; contains Lingula and Tasmanites.
	192.10 - 192.28 Calcisiltite layer, interbedded with black shale, pyritic.
201.00 - 221.00	Shale, black, as above; calcisiltite laminae increase toward base; locally calcareous and pyritic.
	204.64 - 204.60 Cone-in-cone limestone. 217.56 - 217.60 Faint burrowed zone, slight change in color. 214.75 - 214.77 Pyrite layer.
221.00 - 236.50	Shale, black, as above, in obscure bands alternating with brownish-gray (5YR 3/1) to olive-gray (5YR 4/1) laminae in cycles about 1 ft. apart; dark zones about 0.4 ft. thick, light zones 0.6 ft. thick; sparse calcisiltite layers as much as 0.01 ft. thick. Greenish-gray clay shale laminae concentrated between 233.8 and 234.2 ft.; not burrowed.
236.50	Top of Three Lick Bed.
236.50 - 241.00	Clay shale, greenish-gray (5GY 5/1); burrowed; pyrite as scattered blebs and layers. Lower 0.20 ft. olive gray (5Y 3/1).
241.00 - 245.90	Shale, brownish-black (5YR 2/1), with brownish-gray (5YR 3/1) to olive-gray (5Y 3/1) and sparse greenish-gray (5GY 4/1) interlaminae. Scattered calcisiltite.
245.90 - 247.45	Clay shale, greenish-gray (5G 5/1) to medium gray (N 5); burrowed; burrows extend 0.10 ft. into unit below.
247.45 - 251.15	Shale, brownish-black (5YR 2/1), as above.
	248.22 - 248.24 Greenish-gray clay shale. 249.78 - 249.82 Greenish-gray clay shale. 250.39 - 250.42 Greenish-gray clay shale.
251.15 - 254.60	Clay shale, greenish-gray (5G 5/1), burrowed; burrows extend 0.10 ft. into unit below.

Kep No. 8

Depth in feet	Lithology
254.60	Top of Huron Member of Ohio Shale.
254.60 - 291.00	Shale, brownish-black (5YR 2/1), obscurely banded with olive black (5Y 2/1). Calcisiltite laminae sparse.
	263.44 - 263.52 Clay shale, greenish-gray (5GY 5/1); Tasmanites; calcareous with cone-in-cone structure.
	271.87 - 271.91 Cone-in-cone limestone; associated greenish-gray clay shale.
	274.85 - 274.86 Greenish-gray clay shale.
	286.75 - 286.77 Cone-in-cone limestone lamina.
	287.30 Vitrain lamina.
291.00 - 351.00	Shale, as above, with obscure banding noticeable in about 1-ft. cycles. Tasmanites abundant.
	294.44 - 294.48 Greenish-gray clay shale.
	294.60 - 294.63 Cone-in-cone limestone.
	312.70 - 313.50 Fractured.
	316.80 - 317.20 Fractured.
	329.80 - 329.82 Cone-in-cone limestone.
	329.31 - 329.32 Greenish-gray clay shale.
	335.15 - 335.20 Cone-in-cone limestone.
	339.92 - 339.94 Greenish-gray clay-shale interlaminae more numerous.
	347.80 - 347.81 Sparse burrows; greenish-gray cast.
351.00 - 370.95	Shale, brownish-black (5YR 2/1); calcisiltite increases to 2 to 4 laminae per 0.10 ft. in lower part.
	357.55 - 357.57 Greenish-gray clay shale.
	362.67 - 362.71 Greenish-gray clay shale; base sharp.
370.60	Top of Foerstia zone.
370.95 - 380.45	Clay shale, greenish-gray (90 percent) and shale, brownish-black (5YR2/1), with abundant Foerstia and some burrowing in brownish-black shale. Green shale beds are sharp at base, burrowed at top.
	372.35 - 373.80 Brownish-black shale.

Depth in feet	Lithology
370.95 - 380.45 (Continued)	373.81 - 373.90 Brownish-black shale. 374.92 - 375.00 Brownish-black shale. 375.97 - 376.01 Brownish-black shale. 376.36 - 376.37 Brownish-black shale. 376.77 - 376.80 Brownish-black shale. 377.45 - 377.58 Brownish-black shale. 377.59 - 377.64 Cone-in-cone limestone. 378.23 - 378.25 Brownish-black shale. 379.18 - 379.20 Brownish-black shale. 380.33 - 380.33 Brownish-black shale.
380.45 - 391.00	Shale, brownish-black (5YR 2/1); vitrain layer 0.03 ft. below top; scattered calcisiltite laminae; Foerstia, Tasmanites common. 384.79 - 384.80 Greenish-gray clay shale.
381.95	Base of Foerstia zone.
	389.45 - 389.46 Greenish-gray clay shale.
391.00 - 401.00	Shale, brownish-black, (5YR 2/1); calcisiltite laminae locally abundant. Vitrain at 391.40 ft. sampled (J. Hower); pyrite associated with calcisiltite laminae as disseminated crystals.
401.00 - 417.40	Shale, brownish-black (5YR 2/1); looks more dense; calcisiltite laminae common; pyrite concentrated locally along bedding planes.
417.40 - 431.00	Shale, brownish-black (5YR2/1), and clay shale, greenish-gray (5GY4/1), burrowed. Details: 417.40 - 417.42 Greenish-gray shale; 417.42 - 419.03 Black shale; 419.03 - 419.06 Greenish-gray shale; 419.06 - 419.25 Black shale; 419.25 - 419.32 Greenish-gray shale; 419.32 - 419.48 Black shale; 419.48 - 419.50 Greenish-gray shale; 419.50 - 420.19 Black shale; 420.19 - 420.25 Greenish-gray shale; 419.25 - 420.52 Black shale; 419.52 - 420.70 Greenish-gray shale; 419.70 - 420.98 Black shale; 419.98 - 421.10 Greenish-gray shale; 421.10 - 421.37 Black shale; 421.37 - 421.45 Greenish-gray shale; 421.45 - 421.47 Black shale; 421.47 - 421.55 Greenish-gray shale; 421.55 - 422.85 Black shale; 422.85 - 422.93 Greenish-gray shale;

Depth in feet	Lithology
417.40 - 431.00 (Continued)	422.93 - 422.96 Black shale;
	422.96 - 423.00 Greenish-gray shale.
	423.00 - 423.28 Black shale;
	423.28 - 423.35 Greenish-gray shale;
	423.35 - 424.27 Black shale;
	424.27 - 424.29 Greenish-gray shale;
	424.29 - 424.96 Black shale;
	424.96 - 425.00 Greenish-gray shale;
	425.00 - 425.23 Black shale;
	425.23 - 425.40 Greenish-gray shale;
	425.40 - 425.67 Black shale;
	425.67 - 425.70 Greenish-gray shale;
	425.70 - 425.96 Black shale;
	425.96 - 425.98 Greenish-gray shale;
	425.98 - 426.03 Black shale;
	426.03 - 426.10 Greenish-gray shale;
	426.10 - 426.15 Black shale;
	426.15 - 426.16 Greenish-gray shale;
	426.16 - 426.18 Black shale;
	426.18 - 426.21 Greenish-gray shale;
	426.21 - 426.42 Black shale;
	426.42 - 426.48 Greenish-gray shale;
	426.48 - 426.72 Black shale;
	426.72 - 426.77 Greenish-gray shale;
	426.77 - 426.93 Black shale;
	426.93 - 427.03 Greenish-gray shale;
	427.03 - 427.25 Black shale;
	427.25 - 427.28 Greenish-gray shale;
	427.28 - 427.59 Black shale;
	427.59 - 427.64 Greenish-gray shale;
	427.64 - 427.91 Black shale;
	427.91 - 427.97 Greenish-gray shale;
	427.97 - 428.02 Black shale;
	428.02 - 428.17 Greenish-gray shale;
	428.17 - 428.41 Black shale;
	428.41 - 428.45 Greenish-gray shale;
	428.45 - 429.80 Black shale;
	429.80 - 429.86 Greenish-gray shale;
	429.86 - 430.28 Black shale;
	430.28 - 430.40 Greenish-gray shale.
430.40 - 441.93	Shale, brownish-black (5YR 2/1), dense, with occasional burrowed zones and calcisiltite laminae; burrowed zones are greenish gray (5GY 4/1) to olive black (5Y 4/1); details follow:
	431.64 - 431.66 Greenish-gray shale;
	434.32 - 434.34 Greenish-gray shale;
	435.86 - 435.87 Greenish-gray shale;
	436.07 - 436.09 Greenish-gray shale;
	437.47 - 437.50 Greenish-gray shale;
	440.09 - 440.12 Greenish-gray shale;

Depth in feet	Lithology
430.40 - 441.93 (Continued)	440.50 - 440.52 Greenish-gray shale;
	440.82 - 440.83 Greenish-gray shale;
	441.35 - 441.48 Calcisiltite lamina, pyritic.
441.93 - 457.50	Clay shale, greenish-gray (5GY 4/1) and shale, brownish-black (5YR 2/1).
	441.93 - 442.15 Greenish-gray shale.
	442.15 - 442.35 Black shale.
	442.35 - 442.45 Greenish-gray shale.
	442.45 - 442.67 Black shale.
	442.67 - 442.73 Greenish-gray shale.
	442.73 - 443.66 Black shale.
	443.66 - 444.32 Greenish-gray shale.
	444.32 - 444.55 Black shale.
	444.55 - 444.60 Greenish-gray shale.
	444.60 - 444.78 Black shale.
	444.78 - 444.85 Greenish-gray shale.
	444.85 - 445.90 Black shale.
	445.90 - 446.00 Greenish-gray shale.
	446.00 - 446.16 Black shale.
	446.16 - 446.80 Greenish-gray shale.
	446.80 - 447.22 Black shale.
	447.22 - 447.39 Greenish-gray shale.
	447.39 - 447.49 Black shale.
	447.49 - 448.15 Greenish-gray shale.
	448.15 - 448.17 Black shale.
	448.17 - 448.43 Greenish-gray shale.
	448.43 - 448.52 Black shale.
	448.52 - 449.20 Greenish-gray shale.
	449.20 - 449.45 Impure black shale.
	449.45 - 449.73 Greenish-gray shale.
	449.73 - 449.78 Black shale.
	449.78 - 449.92 Greenish-gray shale.
	449.92 - 450.40 Black shale.
	450.40 - 451.00 Greenish-gray shale.
	451.00 - 451.20 Shale, black, burrowed in basal 0.02 ft.
	451.20 - 451.35 Greenish-gray shale.
	451.35 - 452.34 Black shale.
	452.34 - 452.37 Greenish-gray shale.
	452.10 - 452.15 Pyrite.
	452.15 - 452.81 Black shale.
	452.52 - 452.56 Pyrite.
	452.56 - 453.36 Greenish-gray shale.
	453.36 - 453.59 Black shale.
	453.59 - 454.75 Greenish-gray shale.
	454.75 - 455.85 Black shale.
	455.85 - 456.25 Interlaminated green and black shale.

Depth in feet	Lithology
451.00 - 457.50 (Continued)	456.25 - 456.60 Black shale. 456.60 - 457.50 Interlaminated green and black shale.
457.50 - 460.15	Shale, brownish-black (5YR 2/1); common calcisiltite and pyrite laminae; Tasmanites abundant. Bone bed at base is 0.01 ft. thick, pyritic.
460.15 - 462.60	Clay shale, greenish-gray (5GY 4/1), pyritic.
462.60 - 462.80	Shale, olive-gray (5Y 3/1), irregular base.
462.80 - 462.90	Bone bed, pyrite mixture, phosphate and quartz grains and sparse dolomite. Sharp base.
462.90	Unconformity. Top of Bisher Limestone (Silurian).
462.90 - 471.00	Dolomite, light-gray (N 7); dolosiltite to dolograinstone; oil stain, vuggy; dolomitized algal mats.
471.00	Total depth.

Kep No. 9
Charters Quad., Elev. 1140 ft.
3625 ft. FSL X 725 ft. FEL
Sec. 18-Z-73 Lewis Co., Ky.
Completed May 30, 1980

Depth in feet		Lithology
		Borden Formation, lower part.
0.00 -	25.00	No core.
25.00 -	26.60	Clay shale, calcareous, greenish-gray (5GY 5/1), grades down to medium gray (N 5); nodules, glauconitic, pyritic; Chondrites; burrowed, burrows extend 0.2 ft. into unit below.
	26.60	Top of Sunbury Shale.
26.60 -	41.75	Shale, black (N 1) and grayish-black (N 2); sparse silt laminae weathered and soft to 27.65 ft. Sparse pyrite in nodules. Bone bed at 41.65 ft.
41.75 -	41.90	Pyrite layer, silty or sandy.
	41.90	Top of Berea Sandstone.
41.90 -	67.20	Siltstone (90 percent) and clay shale (10 percent). Siltstone is very light gray (N 8), yellowish gray (5Y 7/2) and light gray (N 7); weathered dark yellowish orange (10 YR 6/6) in mottles and streaks; bedding planar to low angle, locally cross-bedded. Clay shale is medium light gray (N 6), mainly as partings at 45.73 - 45.78, 48.20 - 48.23, 48.95 - 48.96, 50.60 - 50.65, and 51.15 - 51.41 ft. Weathering stops below 49.00 ft. Siltstone in thinner beds below 52 ft. (1.30 ft. thick, maximum, and generally less than 0.50 ft. thick).
67.20 -	72.00	Siltstone and shale, as above. Siltstone decreases to 70 percent; shale increases to 30 percent. Siltstone in thin rippled beds, locally discontinuous and bioturbated; less than 0.1 ft. thick.
	72.00	Top of Bedford Shale.
72.00 -	82.00	Siltstone and shale, as above. Siltstone decreases to 50 percent; occasional oil stain; siltstone beds commonly less than 0.05 ft. thick.

Depth in feet	Lithology
82.00 - 92.00	Shale (60 percent) and siltstone (40 percent); otherwise as above.
92.00 - 102.00	Shale and siltstone, as above; shale increases to 70 percent; siltstone discontinuous; few beds continuous for width of core.
102.00 - 116.50	As above; shale increases to 90 percent, darkens to medium gray (N 5); siltstone decreases to 10 percent and shows some oil stain; sideritic bands 2 ft. apart below 112 ft.
116.50 - 120.60	Siltstone (60 percent) and shale (40 percent). Three siltstone turbidites at 116.55 to 117.35 ft., 118.05 to 119.00 ft., and 119.55 to 120.60 ft.; upper bed shows Tbcd sequence of Bouma (1962); tops burrowed; beds oil-stained.
120.60 - 122.00	Clay shale, medium dark gray (N 4), mottled, interlaminated with thin siltstone (sparse). Siderite band at 121.90 - 122.00 ft.
122.00 - 131.00	Clay shale, dark-olive-gray (5Y 3/1) to greenish-gray (5GY 5/1), and sparse shale laminae, medium-dark-gray (N 4) to dark-gray (N 3). Scattered siltstone laminae concentrated in zone at 127.50 - 127.90 ft.; laminae reflect planar and discontinuous bedding; indicate soft-sediment flowage at 128.80 - 129.20 ft. and 129.90 -131.00 ft.; possibly burrowed.
131.00	Top of Cleveland Member of Ohio Shale.
131.00 - 162.00	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1), dense; pyritic; Lingula; sparse calcisiltite laminae below 140 ft., increase below 156.8 ft.; fractured at 136.5 - 137.20 and 143.80 - 145.3 ft. (near vertical). Lingula and spicule bone bed at 156.80 ft.
162.00 - 184.60	Shale, as above; indistinctly banded with dark-olive-gray (5Y 3/1) bands in cycles 1.0 ft. apart. Calcisiltite laminae 1 to 10 per 0.1 ft. Calcisiltite laminae conspicuous at 173.45 - 173.47 ft., 174.15 - 174.16 ft., and 177.72 - 177.74 ft. Pyrite layer at 181.00 - 181.01 ft.

Depth in feet	Lithology
162.00 - 184.60 (Continued)	182.83 - 182.85 Greenish-gray (5GY 5/1) clay shale associated with limestone.
	184.14 - 184.16 Greenish-gray (5GY5/1) clay shale.
	184.40 - 184.41 Pyrite.
184.60	Top of Three Lick Bed.
184.60 - 186.25	Clay shale, greenish-gray (5GY 5/1), mottled, pyritic, burrowed; burrows extend into unit below.
186.25 - 192.05	Shale, brownish-black (5YR 2/1) to dark-olive-gray (5Y 3/1); calcisiltite laminae abundant.
	189.71 - 189.72 Greenish-gray (5GY 5/1) laminae.
192.05 - 193.30	Clay shale, greenish-gray (5GY 5/1); burrowed. Burrows extend into unit below.
193.30 - 196.60	Shale, brownish-black to olive-gray, as above.
	193.99 - 194.01 Greenish-gray clay shale. 194.14 - 194.16 Greenish-gray clay shale. 195.59 - 195.60 Greenish-gray clay shale. 296.13 - 196.14 Greenish-gray clay shale.
196.60 - 199.55	Clay shale, greenish-gray (5GY 5/1); burrows extend 0.10 ft. into unit below.
199.55	Top of Huron Member of Ohio Shale.
199.55 - 262.00	Shale, brownish-black (5YR 2/1) to olive-black (5Y 2/1) with dark-olive-gray (5Y 3/1) banding. Details:
	206.30 - 206.32 Calcisiltite lamina; 207.08 - 207.14 Calcisiltite lamina; 207.40 - 207.41 Greenish-gray clay shale; 208.70 - 208.72 Calcisiltite lamina; 211.80 - 211.82 Calcisiltite lamina; 212.93 - 212.94 Calcisiltite lamina, not continuous; 213.35 - 213.36 Calcisiltite lamina; 215.40 - 215.42 Calcisiltite lamina; 215.62 - 215.64 Calcisiltite lamina; 219.05 - 219.06 Calcisiltite lamina; 225.55 - 225.56 Calcisiltite lamina;

Depth in feet	Lithology
199.55 - 262.00 (Continued)	227.71 - 227.72 Calcisiltite lamina; 229.07 - 229.08 Calcisiltite lamina; 229.76 - 229.77 Calcisiltite lamina; 232.70 - 232.72 Calcisiltite lamina, pyritic; 235.49 - 235.51 Calcisiltite lamina.
262.00 - 272.00	Shale, as above, banded in cycles of about 1 ft. Common calcisiltite laminae. 270.85 - 270.86 Clay shale, greenish-gray (5GY 5/1).
272.00 - 295.75	Shale, banded, as above; pyritic; calcisiltite laminae increase to 1 or 2 per foot, generally less than 0.01 ft. thick. 284.12 - 284.13 Conspicuous calcisiltite.
295.75 - 296.00	Clay shale, dark-greenish-gray (5GY 4/1); irregular and lensing; contact sharp but deformed.
296.00 - 296.65	Shale, brownish-black (5YR 2/1); greenish-gray clay-shale laminae 1 mm thick at 296.25 and 296.27 ft. Basal contact sharp, inclined 5°.
296.65 - 297.95	Clay shale, greenish-gray (5GY 5/1); burrowed.
297.95 - 312.00	Shale, brownish-black (5YR 2/1); calcisiltite common.
298.40	Top of Foerstia zone.
302.35	Base of Foerstia zone.
312.00 - 328.58	Shale, brownish-black (5YR 2/1); calcisiltite common; pyritic in layers and nodules along bedding plane. Sharp base.
328.58 - 342.00	Clay shale, greenish-gray (5GY 5/1) and black shale, as above; burrows extend below top as much as 0.2 ft., commonly 0.05 ft. into black. 328.58 - 328.60 Greenish-gray clay shale. 328.60 - 330.03 Black shale. 330.03 - 330.12 Greenish-gray clay shale. 330.12 - 330.35 Black shale. 330.35 - 330.58 Greenish-gray clay shale. 330.58 - 330.84 Black shale. 330.84 - 330.88 Greenish-gray clay shale. 330.88 - 330.91 Black shale. 330.91 - 330.94 Greenish-gray clay shale.

Depth in feet		Lithology
328.58 - 342.00 (Continued)	330.94 - 331.51	Black shale.
	331.51 - 331.55	Greenish-gray clay shale.
	331.55 - 331.76	Black shale.
	331.76 - 332.05	Greenish-gray clay shale.
	332.05 - 332.07	Black shale.
	332.07 - 332.12	Greenish-gray clay shale.
	332.12 - 332.31	Black shale.
	332.31 - 332.71	Greenish-gray clay shale.
	332.71 - 333.03	Black shale.
	333.03 - 333.29	Greenish-gray clay shale.
	333.29 - 333.31	Black shale.
	333.31 - 333.44	Greenish-gray clay shale.
	333.44 - 334.40	Black shale.
	334.40 - 334.45	Greenish-gray clay shale.
	334.45 - 334.49	Black shale.
	334.49 - 334.56	Greenish-gray clay shale.
	334.56 - 334.74	Black shale.
	334.74 - 334.77	Greenish-gray clay shale.
	334.77 - 334.82	Black shale.
	334.82 - 334.89	Greenish-gray clay shale.
	334.89 - 335.56	Black shale.
	335.56 - 335.59	Greenish-gray clay shale.
	335.59 - 336.25	Black shale.
	336.25 - 336.30	Greenish-gray clay shale.
	336.30 - 336.53	Black shale.
	336.53 - 336.58	Greenish-gray clay shale.
	336.58 - 336.59	Black shale.
	336.59 - 336.73	Greenish-gray clay shale.
	336.73 - 337.00	Black shale.
	337.00 - 337.02	Greenish-gray clay shale.
	337.02 - 337.32	Black shale.
	337.32 - 337.33	Greenish-gray clay shale.
	337.33 - 337.37	Black shale.
	337.37 - 337.41	Greenish-gray clay shale.
	337.41 - 337.46	Black shale.
	337.46 - 337.47	Greenish-gray clay shale.
	337.47 - 337.52	Black shale.
	337.52 - 337.56	Greenish-gray clay shale.
	337.56 - 337.76	Black shale.
	337.76 - 337.84	Greenish-gray clay shale.
	337.84 - 338.12	Black shale.
	338.12 - 338.33	Greenish-gray clay shale.
	338.33 - 338.55	Black shale.
	338.55 - 339.75	Greenish-gray clay shale.
	339.75 - 339.78	Black shale.
	339.78 - 340.07	Greenish-gray clay shale.
	340.07 - 340.29	Black shale.
	340.29 - 340.71	Greenish-gray clay shale.
	340.71 - 340.77	Black shale.
	340.77 - 340.92	Greenish-gray clay shale.
	340.92 - 341.00	Black shale.
	341.00 - 341.01	Greenish-gray clay shale.
	341.01 - 341.15	Black shale.

Depth in feet	Lithology
328.58 - 342.00 (Continued)	341.15 - 341.16 Greenish-gray clay shale. 341.16 - 341.24 Black shale. 341.24 - 341.25 Greenish-gray clay shale. 341.25 - 341.57 Black shale. 341.57 - 341.63 Greenish-gray clay shale. 341.63 - 341.89 Black shale. 341.89 - 342.00 Green and black shale (six green and five black beds). 334.95 - 334.96 Calcisiltite laminae.
342.00 - 347.10	Shale, brownish-black (5YR 2/1); calcisiltite laminae. 343.29 - 343.31 Clay shale, greenish-gray. 343.81 - 343.84 Clay shale, greenish-gray. 345.35 - 345.37 Clay shale, greenish-gray. 347.10 Base, bone bed; Conodonts (USGS collection 10204-SD).
347.10 - 351.90	Clay shale, greenish-gray (5GY 5/1). Ten dark-olive-gray (5Y 3/1) laminae less than 0.03 ft. thick. 349.51 - 349.55 Bed of pyrite spheres and conodonts. 351.90 - 351.93 Bone bed, conodont-rich; Tasmanites abundant, medium-gray (N 5).
351.93	Unconformity. Top of Silurian Bisher Limestone.
351.93 - 352.00	Dolomitic limestone, dark-yellowish-brown (10 YR 2/2) to pale-yellowish-brown (10YR 6/2) to medium-light-gray (N 6); very fossiliferous; porous in part; stylolitic in part; silicified in part. Crinoidal wackestone to grainstone.
352.00 - 372.00	Dolomitic limestone, as above. Clay-shale partings are dark olive gray (5Y 3/1); 0.05 to 0.10 ft. thick, sparse. 358.50 - 358.53 Clay shale. 361.55 - 361.60 Clay shale. 366.65 - 366.70 Clay shale. 367.07 - 367.08 Clay shale. 369.60 - 369.62 Clay shale.

Depth in feet	Lithology
372.00 - 382.00	Dolomitic limestone, as above. Clay shale partings, locally burrowed:
	376.05 - 376.15 Clay shale parting;
	377.03 - 377.05 Clay shale parting;
	378.90 - 378.91 Clay shale parting;
	379.33 - 379.52 Clay shale parting;
	380.38 - 380.41 Clay shale parting;
	381.33 - 381.37 Clay shale parting.
382.00	Total depth.

Le No. 2
Charters Quad., Elev. 995 ft.
1450 ft. FWL X 300 ft. FSL
Sec. 10-Y-73, Lewis Co., Ky.

Depth in feet		Lithology
		Borden Formation, lower part.
0.00 -	32.00	No core.
32.00 -	33.15	Sandstone, silty, platy, yellowish-brown (10YR 6/2) to dark-yellowish-brown (10YR 4/2), finely laminated, weathered.
	33.15	Top of Cleveland Member of Ohio Shale.
33.15 -	42.00	Shale, black (N 1) to grayish-black (N 2) with thin (0.01 ft.) light-gray (N 7) shale streaks at 33.57 and 35.00 ft. Mixed dark-brown (10YR 4/2) and black (N 1) zone from 33.75 to 33.90 ft. is probable burrowed interval; pyrite blebs at 39.45 and 40.73 ft.
42.00 -	52.00	Shale, black (N 1) to grayish black (N 2); obscure burrowed zone at 45.93 - 45.95 ft.
52.00 -	52.55	Shale, black (N 1).
52.55 -	62.00	Shale, brownish-black (5YR 2/1); pyritic, light-gray (N 7) siltstone lamina at 58.78 - 58.80 ft., pyrite blebs at 55.78 and 59.00 ft.
62.00 -	72.00	Shale, brownish-black (5YR 2/1), thin (0.01 ft.) siltstone lamina at 62.0 and 63.25 ft.; pyritic band at 65.95 - 65.98 ft.
72.00 -	82.00	Shale, brownish-gray (5YR 3/1); calcisiltite lamina more prevalent toward the base; 0.01-ft. band of dark-greenish-gray shale (5G 4/1) at 81.80 ft.
82.00 -	84.80	Shale, brownish-black (5YR 2/1).
	84.80	Top of Three Lick Bed of Ohio Shale.
84.80 -	87.10	Shale, brownish-black (5YR 2/1), interbedded with greenish-black shale (5GY 2/1).
87.10 -	87.45	Shale, dark-greenish-gray (5G 4/1); burrowed.

Depth in feet	Lithology
87.45 - 92.55	Shale, brownish-black (5YR 2/1), medium-gray (N 4) clay lamina at 90.40 ft.
92.55 - 93.95	Shale, greenish-gray (5G 5/1), burrowed.
93.95 - 97.29	Shale, brownish-black (5YR 2/1), greenish-gray (5G 5/1) band at 94.75 - 94.80 ft.
97.29 - 100.35	Shale, greenish-gray (5G 5/1), burrowed.
100.35	Top of Huron Member of Ohio Shale.
100.35 - 102.97	Shale, grayish-black (N 2), with clay shale partings at 102.24, 102.56, and 102.59 ft.
102.97 - 112.00	Shale, grayish-black (N 2), grading to brownish-black (5YR 2/1).
112.00 - 122.00	Shale, brownish-black (5YR 2/1) to grayish-black (N 2); scattered pyrite nodules; medium-gray (N 5) burrowed zone at 120.55 ft., 0.02 ft. thick, pyritic.
122.00 - 132.00	Shale, greenish-black (5YR 2/1) to grayish-black (N 2), pyritic; calcisiltite bands 0.03 ft. thick at 126.04 and 128.40 ft.; pyrite bleb at 131.70 ft.
132.00 - 136.67	Shale, as above;, scattered pyrite.
136.67 - 137.32	Calcisiltite mixed with grayish-black (N 2) shale, bone bed.
137.32 - 142.00	Shale, grayish-black (N 2); 0.06 ft. thick; pyrite nodule at 137.52 ft.
142.00 - 152.00	Shale, brownish-black (5YR 2/1), calcisiltite lamina at 143.24 ft.; pyrite nodules 0.04 ft. thick at 145.08 and 151.32 ft.
152.00 - 155.76	Shale, black (N 1) to grayish-black (N 2).
155.76 - 162.00	Shale, grayish-black (N 2) to brownish-black (5YR 2/1), gray (N 6) calcisiltite band, 0.02 ft. thick at 161.28 ft.; irregular pod of dolomitic, pyritic siltstone at 161.40 ft.; pyrite nodule at 161.65 ft.
162.00 - 163.85	Shale, grayish-black (N 2). Details:
162.24	Medium-gray (N 6) calcisiltite band 0.02 ft. thick; dips 15 degrees;

Depth in feet		Lithology
162.00 - 163.85 (Continued)	162.87	Calcisiltite band, as above, 0.01 ft. thick, dips 20 degrees.
	162.96 - 163.25	Calcisiltite band, as above, cross-bedded.
	163.54	Medium-gray (N 4) shale band 0.01 ft. thick.
163.85 - 165.40		Calcisiltite concretion, light- to medium-gray (N 6 to N 5); pyrite veins and blebs; burrowed and contorted bedded.
165.40 - 171.82		Shale, grayish-black (N 2); scattered pyrite blebs and laminae; calcisiltite laminae filling soft-sediment deformational fractures.
171.82 - 172.00		Shale, black (N 4).
172.00 - 182.00		Shale, brownish-black (5YR 2/1) to black (N 1), occasional light-gray (N 6) laminae; calcisiltite laminae at 172.55 ft. with 10-degree dip.
182.00 - 192.00		Shale, grayish-black (N 2) to brownish-black (5YR 2/1).
192.00 - 202.00		Shale, as above, greenish-gray (5G 4/1); burrowed interval from 195.15 to 195.59 ft.; pyritic calcisiltite lamina at 200.9 ft. (0.01 ft. thick).
202.00 - 212.00		Shale, brownish-black (5YR 2/1) to black (N 1); pyritic calcareous siltstone laminae at 203.16 and 208.21 ft. (0.01 and 0.05 ft. thick).
	202.30	Top of Foerstia zone.
	204.60	Base of Foerstia zone.
212.00 - 222.00		Shale, as above; siltstone laminae more abundant; occasional pyrite blebs.
222.00 - 232.00		Shale, as above; occasional calcisiltite laminae; scattered pyrite blebs. (Core was jumbled in core box.)
232.00 - 238.93		Shale, brownish-black (5YR 2/1), interbedded with burrowed, greenish-gray shale (5G 6/1 to 5G 4/1); footages of burrowed zone, with other details as follows:
	232.00 - 233.18	Shale, black, as above;

Depth in feet		Lithology
232.00 - 238.93 (Continued)	233.18 - 233.40	Shale, greenish-gray;
	233.57 - 233.77	Shale, greenish-gray;
	233.82 - 234.00	Shale, greenish-gray;
	234.00 - 235.05	Shale, black, with calcisiltite laminae, large burrows at base as much as 0.10 ft.;
	235.05 - 235.18	Shale, greenish-gray;
	235.18 - 235.22	Shale, black, burrowed at the base;
	235.22 - 235.50	Shale, greenish-gray, basal contact sharp;
	235.50 - 235.75	Shale, black, bioturbated zone at base (0.06 ft. thick);
	235.75 - 236.45	Shale, greenish-gray, with siderite pellets;
	236.67 - 236.72	Shale, greenish-gray;
	236.79 - 237.25	Shale, greenish-gray;
	237.47 - 237.57	Shale, greenish-gray;
	238.20 - 238.25	Shale, greenish-gray;
	238.25 - 238.46	Shale, black, with a siltstone nodule;
	238.46 - 238.89	Shale, greenish-gray, burrowed at the top grading to shale, black;
	238.89 - 238.93	Shale, greenish-gray.
238.93 - 242.00		Shale, black, with laminae of pyrite, calcisiltite, and siderite nodule (0.06 ft. thick).
242.00 - 252.00		Shale, grayish-black to brownish-black (N 2 to 5YR 2/1), interbedded with burrowed greenish-gray shale (5G 6/1). The distribution of the burrowed intervals is as follows:

242.00 - 242.18
242.33 - 242.78
242.99 - 243.04
243.38 - 243.67
243.85 - 244.00
244.10 - 244.23
244.37 - 244.46
244.54 - 244.77
245.36 - 245.46
245.67 - 245.74
245.91 - 246.00
247.03 - 247.09
247.49 - 247.54
251.42 - 251.55
251.80 - 251.88

Depth in feet	Lithology
252.00 - 262.00	Shale, greenish-gray (5G 6/1), bioturbated, with occasional grayish-blacks (N 2) or brownish-black (5YR 2/1) bands. A thin sandy "bone bed" is present at the base of the interval; the distribution of the black-shale intervals is as follows: 252.00 - 252.27 252.60 - 252.63 252.65 - 252.72 254.09 - 254.13 254.61 - 254.68 254.73 - 254.82 254.90 - 255.05 255.40 - 255.46 256.06 - 256.14 256.18 - 256.34 256.40 - 256.61 256.71 - 256.74 258.04 - 258.07 258.53 - 258.67 259.07 - 259.09 260.00 - 260.06 260.29 - 260.31 260.40 - 260.52
262.00	Total depth.

Le No. 3
Charters Quad., Elev. 1020
2300 ft. FEL X 0 ft. FSL
Sec. 25-Y-73, Lewis Co., Ky.

Depth in feet	Lithology
0.00 - 22.00	Not cored; core interval begins in the Cleveland Member of the Ohio Shale.
22.00 - 32.00	Shale, black (N-1), with occasional olive-gray (5Y 4/1) streaks and pyrite blebs; Tasmanites and Lingula common. Pyrite nodule at 28.9 ft.
32.00 - 42.00	Shale, as above; olive-gray calcareous streaks present. Pyrite nodule at 34.37 ft., massive pyrite from 41.70 to 41.80 ft.
42.00 - 45.76	Shale, as above, olive-gray (5Y 4/1); calcareous pyritic band at 44.23 ft.
45.76 - 46.98	Shale, grayish black (N 2), with abundant calcareous laminae, dark-gray (N 3), Pyrite nodule at 46.88 ft.; Tasmanites and Lingula common.
46.98 - 52.00	Shale, black (N 1) to grayish-black (N 2) with abundant dark-gray laminae (N 3); occasionally calcareous.
52.00 - 62.00	Shale, as above. Details: 52.91 - 53.06 Olive-gray (5Y 4/1) band; 53.90 - 54.10 Grayish-black (N 2) calcareous band; 59.22 - 59.25 Pyrite band.
62.00 - 72.00	Shale, grayish-black (N 2) to black (N 1). Details: 62.39 - 62.47 Calcareous band; 63.69 - 63.72 Pyrite band; 70.25 - 70.27 Calcareous band with pyrite nodule.
72.00 - 72.37	Shale, grayish-black (N 2), grading to dark-greenish-gray (5G 4/1).
72.37	Top of Three Lick Bed of the Ohio Shale.
72.37 - 73.97	Shale, dark-greenish-gray (5G 4/1); pyrite-filled burrows.

Depth in feet	Lithology
73.97 - 74.09	Shale, dark-gray (N 3); interlaminated with dark-greenish-gray (5G 5/1) shale; burrowed.
74.09 - 79.46	Shale, grayish-black (N 2) to black (N 1). Details:
	76.67 - 76.73 Grayish-black shale (N 2), calcareous;
	79.14 - 79.21 Shale, grayish-black, calcareous;
	78.61 Dark-gray (N 3) band with pyrite nodule.
79.46 - 82.00	Shale, dark-greenish-gray (5G 4/1), burrowed; grading to grayish-black (N 2) with dark-gray (N 3) laminae.
82.00 - 91.95	Shale, grayish-black (N 2) to dark-gray (N 3); interbedded with burrowed greenish-gray (5G 4/1) shale containing abundant pyrite. The contacts of the burrowed zones with the black shales are sharp; the distribution of the burrowed zones is as follows:
	82.40 - 82.50
	82.61 - 82.65
	82.75 - 82.92
	82.98 - 83.05
	83.28 - 83.45
	83.83 - 83.87
	84.74 - 84.88
	84.94 - 85.14
	85.33 - 85.39
	85.42 - 85.46
	85.51 - 85.53
	86.38 - 86.64
	87.06 - 87.10
	87.14 - 87.19
	87.47 - 87.70
	88.00 - 88.03
	88.42 - 88.47
	88.52 - 88.67
	88.96 - 89.03
	89.07 - 89.15
	89.23 - 89.30

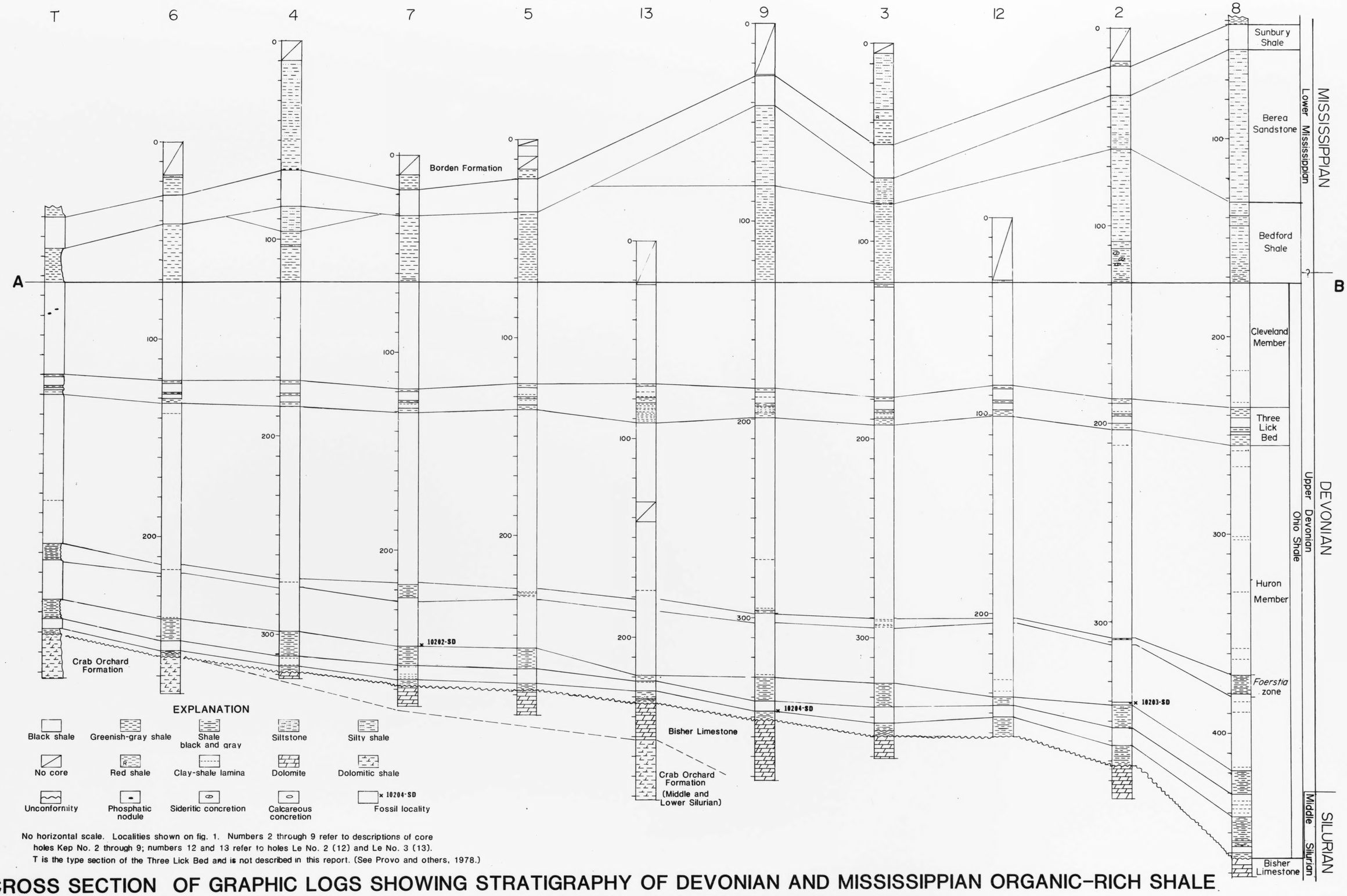
Depth in Feet	Lithology
82.00 - 91.95 (Continued)	89.34 - 89.38 90.16 - 90.30 90.37 - 90.43 90.52 - 90.59 90.71 - 90.75 90.82 - 90.97 91.01 - 91.06 91.13 - 91.20 91.26 - 91.31 91.50 - 91.61 91.87 - 91.95
91.95	Top of the Huron Member of Ohio Shale.
91.95 - 101.60	Shale, grayish-black (N 2) to black (N 1);, greenish-gray (5G 4/1) burrowed zone present at 92.50 - 92.60 ft.
101.60 - 102.00	Shale, as above, with abundant dark-gray (N 3) laminae.
102.00 - 112.00	Shale, grayish-black (N 2), with zones of light-gray (N 7) calcareous laminae at: 102.74 - 102.76 ft. 103.43 - 103.59 ft. 104.98 - 105.09 ft. 109.15 - 109.24 ft.
112.00 - 122.00	Shale, grayish-black (N 2) to olive-black (5Y 2/1); greenish-black laminae (5Y 4/1), pyritic, slightly burrowed locally. Conspicuous laminae at 113.1, 118.3 and 118.9 ft., pyrite bleb at 121.03 ft.
122.00 - 132.00	Shale, as above, with pyrite blebs at 123.65, 126.96 and 129.7 ft. Cone-in-cone limestone band at 124.30 - 124.33 ft.
132.00 - 142.00	Interval missing, probably as above.
142.00 - 176.20	Shale, grayish-black (N 2) to dark-gray (N 3); sparse Tasmanites present; scattered pyrite blebs, thin calcareous laminae at 142.17, 144.63, 147.50, 148.20, and 151.36 ft.
176.20 - 176.50	Shale, dark-greenish-gray (5GY 4/1); planar top and bottom; obscure burrowing.

Depth in Feet	Lithology
176.50 - 192.00	Shale, grayish-black (N 2) to dark-gray (N 3). Details:
	176.50 - 178.50 Fractured; calcite filling; 179.40 Pyrite lamina; 180.70 Pyrite lamina; 181.35 Top of Foerstia zone; 182.30 Pyrite laminae; 187.50 Base of Foerstia Zone; 187.50 Pyrite lamina; 190.75 Pyrite lamina; 188.00 - 192.00 Calcisiltite laminae, 2 to 3 per foot.
192.00 - 211.30	Shale, as above, grading to brownish-black (5YR 2/1); calcisiltite laminae more abundant below 193.50 ft., up to 10 per foot., pyrite increasing below 203.60 ft. Tasmanites more abundant than above. Pyrite nodule at 207.20 ft.; vitrinite band at 208.45 ft.
211.30 - 218.90	Shale, brownish-black, as above, interbedded with greenish-gray (56Y 4/1) shale, burrowed. The greenish-gray shale beds are as much as 0.60 ft. thick and constitute 37 percent of total interval.
218.90 - 222.00	Shale, dark-greenish-gray (5GY 4/1), with three thin interbeds of black shale totaling 0.3 ft. in thickness. Base of interval burrowed.
222.00 - 227.80	Shale, brownish-black (5YR 2/1);, abundant Tasmanites; burrowed zones at: 222.20 - 222.22 ft.; 222.42 - 222.45 ft.; 223.05 - 223.17 ft.
227.80 - 233.50	Shale, dark-greenish-gray; burrowed, with a small amount (5 percent) of black shale in poorly defined zones as much as 0.10 ft. thick; sandy, pyritic, burrowed. Bone beds at 230.85 and 231.60 ft., and at base.
233.50	Top of Bisher Dolomite. (Silurian)

Depth in feet	Lithology
242.00 - 251.70	Dolomite, olive-gray (5YR 4/1) to greenish-gray (5GY 6/1), with yellowish-gray (5Y 8/1) to light-gray (N 7) mottles, burrowed and micritic; contains mudstone interval from 242.50 to 243.80 ft.
251.70	Top of Crab Orchard Formation.
251.70 - 252.00	Shale, medium-gray (N 5), slightly dolomitic.
252.00 - 262.00	Interval missing, probably as above.
262.00 - 282.00	Shale, as above.
282.00	Total depth.

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Open-File Report 82-219
Plate 1



No horizontal scale. Localities shown on fig. 1. Numbers 2 through 9 refer to descriptions of core holes Kep No. 2 through 9; numbers 12 and 13 refer to holes Le No. 2 (12) and Le No. 3 (13). T is the type section of the Three Lick Bed and is not described in this report. (See Provo and others, 1978.)

CROSS SECTION OF GRAPHIC LOGS SHOWING STRATIGRAPHY OF DEVONIAN AND MISSISSIPPIAN ORGANIC-RICH SHALE IN CORES AND A SURFACE SECTION IN NORTHEASTERN KENTUCKY

By Roy C. Kepferle, John G. Beard, and James D. Pollock